SUEMoT

SUE-MoT Conference 2009

Second International Conference on Whole Life Urban Sustainability and its Assessment

Loughborough, UK *22-24 April 2009*

Conference Proceedings

Editors: M. Horner, A. Price, J. Bebbington, R. Emmanuel

First published in Great Britain in 2009 by Loughborough University

Typeset in Warnock Pro using Adobe InDesign, XeLaTeX and PDF::Reuse by James Sutherland, University of Dundee

All papers were double-blind reviewed.

ISBN-13 978 0 947974 81 7

Conference Chair

Prof. Malcolm Horner
University of Dundee

Conference Organising Committee

Prof. Malcolm Horner, Prof. Cliff Hardcastle, Prof. Andrew Price, Prof. Jan Bebbington, Dr Rohinton Emmanuel, Dr Mohamed El-Haram, Dr Jonathan Walton, Dr Craig Thomson, Dr Primali Paranagamage, Toby Atkin-Wright, James Sutherland, Fahmida Khandokar

International Scientific Advisory Committee

Prof. Simon Austin (UK), Prof. Jan Bebbington (UK), Prof. Elizabeth Burton (UK), Prof. Raymond J Cole (Canada), Prof. Rachel Cooper (UK), Prof. Stephen Curwell (UK), Prof. Zhu Dajian (China), Prof. Nash Dawood (UK), Prof. Malcolm Horner (UK), Prof. Bengt Larsson (Sweden), Prof. Anita Liu (UK), Prof. Patrizia Lombardi (Italy), Prof. Silvio Melhado (Brazil), Prof. Jan Rotmans (Netherlands), Prof. Fulong Wu (UK), Dr Adjo Amekudzi (USA), Dr David Blackwood (UK), Dr Francis Edum-Fotwe (UK), Dr Peter Edwards (Australia), Dr Mohamed El Haram (UK), Dr Rohinton Emmanuel (UK), Dr Cletus Moobela (UK), Dr Monjur Mourshed (UK), Dr Primali Paranagamage (UK), Dr Kate Theobald (UK), Dr Craig Thomson (UK), Dr Jonathan Walton (UK)

Contents

Measuring the environmental performance of office space: a Bristol case study

Jorn van de Wetering, Dr Peter Wyatt
University of the West of England, UK

This paper investigates how the existing stock of medium to large office buildings in a typical UK city performs in relation to current environmental sustainability benchmarks. The vast majority of office space in any UK city is not new; over two thirds of the stock in England & Wales was constructed before 1985. Whereas current efforts to benchmark the environmental sustainability focus on the design and procurement of new buildings, this paper examines the management and occupation of existing buildings. Most of the existing office stock that is here today will still be standing for decades to come and will therefore pose a challenge. The stock will be subject to increasingly stringent energy and CO_2 reduction targets, such as the government's commitment to reduce emissions by 60% before 2050 as laid down in the Climate Change Bill. The paper focuses on two aspects of environmental performance in particular. Energy use is considered both in terms of operational energy consumption relating to the building itself and in terms of transport energy consumed while commuting to and from the building. The research focuses on speculatively built office buildings of 10,000 square feet or more that have been constructed or refurbished in Bristol between 1956 and 2007. The buildings in the sample are located in the city centre and in out-of-town business parks. The stock of over 400 buildings is firstly classified in terms of type, age and location and information on rents, lease terms, vacancy rates. The buildings in the sample are classified into four categories: Naturally Ventilated Cellular, Naturally Ventilated Open Plan, Air Conditioned Standard and Air Conditioned Prestige. Using this classification an estimate of energy use and CO_2 emissions is made, and it is established how well Bristol performs within a wider context. Also, assumptions are made about the potential for the reduction of energy and CO_2. The numbers are visualised and put into context. Also, the number of CO_2 emissions per office occupant in Bristol is given. Taking the BREEAM Management & Occupation Assessment Method, the environmental performance of the stock is secondly examined in terms of their transport emissions. Using a Geographic Information System (GIS) analysis their general location and proximity to public transport facilities and proximity to transport nodes is established. Transport emissions are then estimated and classified by mode of transport. The findings of the research reveal how potentially difficult it might be for existing offices to meet increasingly stringent mandatory and discretionary environmental performance standards.

Keywords: assessment tools, carbon footprint, energy, environmental assessment, office occupation, sustainability assessment, sustainability metrics and indicators, sustainable built environment, transport

1. INTRODUCTION

In terms of commercial enterprise and public service provision, 'sustainability' generally refers to the notion that organisations should seek to balance the present and future economic, social and environmental costs of what they do and this notion has rapidly become a central issue for four important reasons: worldwide reaction to the effects of climate change, growing consumer awareness of green issues, the rising and more volatile cost of energy and increased legislation on sustainability. The result has been the emergence of a stream of environmental thinking that has affected virtually all branches of the economy, including real estate. In the UK office sector there is an increasing number of 'green' offices, the emergence of voluntary environmental assessment schemes such as BREEAM and mandatory energy measurement following the implementation of the EU Energy Performance of Buildings Directive. Furthermore, a growing number of companies have formulated Corporate Social Responsibility policies and although for some this might constitute a means of enhancing image, for others it appears to a more genuine attempt to improve staff retention or reduce energy costs. There appears to be a growing demand among both clients of the services that office occupiers provide and the staff that provide them for more sustainable service provision, including the built environment in which it is provided.

However, the supply of and demand for property is not a simple two-party relationship. There are developers, architects, builders, tenants and owners, and conflicting requirements between these parties are often cited as a key reason why sustainability has failed to gain a significant foothold in the real estate sector of the economy. This is a particular issue for speculatively developed office space, which accounts for around half of the stock (IPF, 2005). The lack of a simple two-party market is not the only economic hurdle; real estate is a durable good so improving the environmental performance of new buildings, which only account for 1.5% of the total stock at any one time (ODPM, 2006), will lead to a very gradual improvement in the built environment as a whole. Yet the current focus of research and benchmarking is on new-build rather than existing buildings.

This paper investigates the environmental performance of existing office space by estimating energy consumption and CO_2 emission resulting from the two main contributory processes, namely building operation and commuting to and from the premises. Section two of the paper reviews research that shows building operation and commuting / business travel to be major sources of energy consumption / CO_2 emission in the offices sector of the real estate market. Section three details the research method and section four presents the findings.

2. OPERATIONAL AND COMMUTING-RELATED ENERGY CONSUMPTION

2.1 Building operation

Total energy use associated with an office building can be classified into four main types (Cole and Kernan, 1996):

- Construction: 'Once only' energy used to construct the building and which is subsequently embodied in its structure. This is the concern of the developer/funder/initial investor and attempts to minimise this type of energy use will include the construction of a durable and adaptable building that re-cycles existing materials and is located on previously developed land.
- Maintenance & Repair: Recurring energy to:
  - maintain the building services and interior finishes usually on an annual basis – typically a concern of current and future occupiers
  - refit/refurbish/alter an existing building – a concern of current and future investors

  In aggregate these are significant costs: according to Keeping & Shiers (1996) over half of all building work in the UK involves refurbishment or works to existing buildings.
- Operation: Heat, cool, ventilate, light and power. This is the concern of occupiers. Cole & Kernan (1996) examined the energy used by a 4,620m^2 (50,000ft^2) three-storey office building and found that, over a typical life of 50 years, operational energy represents 80-90% of the life cycle energy costs and recurring energy is approximately the same as the initial energy (5-10% of life-cycle energy). Bordass (2000) argues that even over a much shorter period of 25 years "…the capital cost of an office building can be dwarfed by factors of 5-10 by those of operation, maintenance and repair".
- Demolition: Considered to be a very small amount of energy compared to the other three types.

Operational energy consumption in office buildings has been increasing for several reasons; an increase in total stock, changing work patterns (more intensive use and longer hours), greater use of electrical equipment in office work and a shift to out-of-town office locations. Research by the Carbon Trust (2000) revealed wide variation in the amount of energy consumed / CO_2 emitted when offices are classified by type, as shown in table 1.

Table 1: Annual energy consumption (kWh/m² of treated floor area) and CO_2 emission (kgCO_2/m² of treated floor area)

	Naturally Ventilated Cellular [I]		Naturally Ventilated Open Plan [II]		Air-conditioned Standard [III]		Air-conditioned Prestige [IV]	
	Typical	Good	Typical	Good	Typical	Good	Typical	Good
Energy use:								
o Gas or oil	151	79	151	79	178	97	210	114
o Electricity	54	33	85	54	226	128	358	234
CO_2 emission:								
o Gas or oil	7.9	4.1	7.9	4.1	9.3	5.0	10.9	5.9
o Electricity	6.9	4.2	10.8	6.9	28.7	16.3	45.5	29.7

Source: The Carbon Trust (2000)

[I] usually small, simple, sometimes converted residential property, 100-3,000m2
[II] purpose-built, sometimes converted industrial property, 500-4,000m2
[III] large, purpose-built or speculatively built, 2,000-8,000m2
[IV] national/regional HQ or technical/administrative centre, 4,000-20,000m2

More recent research by McAllister and Cyril Sweett (2007) revealed a significant difference in energy consumption between new and existing office buildings. The findings are summarised in table 2.

Table 2: Annual energy consumption (kWh/m²) of new and existing office buildings

	Naturally Ventilated Cellular		Naturally Ventilated Open Plan		Air-conditioned Standard		Air-conditioned Prestige	
	Exist	New	Exist	New	Exist	New	Exist	New
Energy use:								
o Gas	145	<75	145	75	175	95	200	100
o Electricity	55	<35	90	55	225	125	360	350
CO_2 emission:								
o Gas	7.5	<3.9	7.5	3.9	9.1	4.9	10.4	5.2
o Electricity	7.0	<4.4	11.4	7.0	28.6	15.9	45.7	44.5

Source: McAllister and Cyril Sweett (2007)

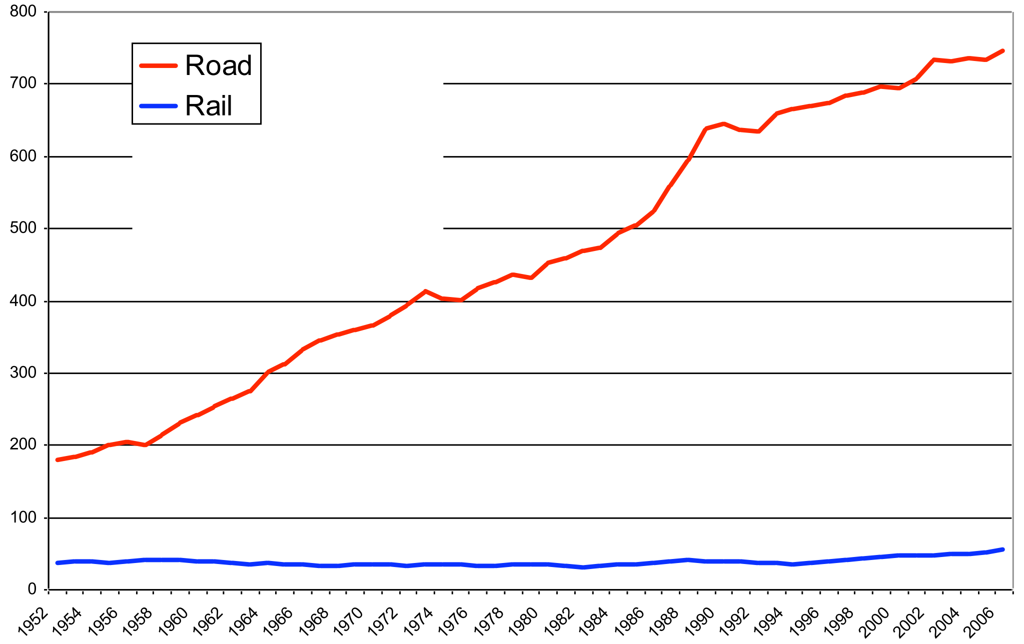
If we assume that the 'typical' and 'good' categories in table 1 correspond with 'existing' and 'new' in table 2 the findings correspond quite well. The biggest difference can be seen in electricity use for new air-conditioned prestige office buildings. According to Wade *et al* (2003) over half of the offices built in the 1990s had air-conditioning compared to 43% in the 1980s and 36% in the 1970s, but these figures do not take into account retro-fitting of air-conditioning systems to existing buildings during refurbishments.

2.2 Transport

Over the past half century widespread use of the car as a means of transport for office workers has freed households and businesses from the need to locate close to public transport nodes. Instead they have been able to decentralise to suburban, edge- and to out-of-town locations where land is cheaper and development is usually quicker and cheaper (as a result of fewer constraints relating to ownership, planning and previous uses). Developers, purchasing cheap land, building cheaply and letting at rents comparable to nearby urban locations, were able to reap increased profit at lower risk. Business occupiers, when deciding to locate in edge- and out-of-town locations, have been able to externalise some of the transport-related costs associated with a city centre location. And homeowners, faced with considerable house price inflation, have located at increasing distances from workplaces because travel costs have not inflated at the same rate. In effect, rising housing costs have been traded off against lowering travel costs at an increasing rate, thus extending the distances people are prepared to commute. This has created environmental costs (local pollution and global climate change) and social costs (congestion, traffic accidents and the undermining of local communities).

These trends are borne out in travel data collected by the Government. The distances people are now prepared to travel have shown a marked increase, as show in figure 1. The impact of the recession of 1989-93 is clear and there are some one-off effects such as the fuel protest in September 2000. The average distance people travel annually has increased by nearly 60 per cent since 1972/73 from around 4,500 miles to about 7,133 miles in 2006 (Department for Transport, 2006 and 2007). This is due to the combined effect of an increase in average trip lengths of nearly 50 per cent and an increase in the number of trips made per person per year of 8 per cent. Commuting/business trips accounted for 29 per cent of this figure (2,073 miles) and 78 per cent of this commuting/business travel is by car (either as driver of passenger). This has major implications for environmental sustainability of office space due to the amount of CO_2 emitted by car-based commuting in comparison to public transport modes. *See figs from National Atmospheric Emissions Inventory…*

Figure 1: Passenger transport by road (billions kms)



Source: Transport Statistics Great Britain: 2007 Edition, ONS and DfT, Table 1.1

Two important questions to ask are whether some office locations generate more commuting/business travel than others and whether some locations generate more car-based commuting/business travel than others. Titheridge and Hall (2006) reported findings of research undertaken in the United States that found that office decentralisation led to longer journey distances and greater use of private vehicles. They also cited research in the Netherlands which found that developments in existing city limits attracted a greater proportion of public transport commuting than urban extension or rural developments, and in Canada there was found to be significant variation in public transport patronage depending on whether the urban form was decentralised (26%), compact (35%) or nodal (29%). In the UK Titheridge and Hall (2006) found that the creation of new growth centres in South East England led to increased car use as the centres provide less opportunities for access by rail.

Case study research in the UK shows that location in the city centre or out-of-town is significant in terms of travel mode (Department for Transport, 2005). Orange plc has 2,200 staff located at sites on the Aztec West and Almondsbury business parks eight miles to the north of Bristol city centre. Both parks have poor public transport penetration; one public bus service serves Almondsbury Business Park and two serve Aztec West. In 2001, five years after introducing a travel plan, the proportion of staff commuting to these office locations by car was 86%, a proportion broadly in line with the 79% of staff who commute to the nearby Frenchay campus of the University of the West of England[1]. In the same year 750 staff were relocated to Temple Point in Bristol city centre, 100 metres

[1] According to figures from UWE's travel planner (April 2008).

from the mainline railway station and 23 public bus services. Only 31% of staff commute to this office location by car. As Orange stated "[t]he experience of Orange is particularly dramatic in demonstrating the locational advantages of a town centre" (Department for Transport, 2005). But these figures are not unique. Bristol City Council collected travel data from companies situated at the nearby Temple Quay business park in the city centre and these are shown in table 3. The figures suggest that Orange's performance is broadly comparable with other organisations in the locality that are involved in travel planning.

Table 3: City centre and out-of-town commuting modes

	Out-of-town	**City centre**			
	Orange (2001)	**Orange (2001)**	**Andersons (2001)**	**Bristol and West (2000)**	**DAS (2000)**
Car driver	79	27	23	28	29
Car passenger	7	4		8	21
Bus	7	22	23	36	25
Train	-	16	29	13	9
Walk	4	13	19	9	10
Bike	2	9	6	6	4
Motorbike	2	8	-	2	2
Other	0	1	-	-	-

The city centre figures for car-based commuting in table 3 can be contrasted with those in table 4 which shows the results of an annual survey of three employers located in the business parks on the north fringe of Bristol. The survey is undertaken by South Gloucestershire Council and the three employers are the Ministry of Defence, South Gloucestershire Council and Atkins.

Table 4: Travel-to-work mode of three major employees located on the Bristol north fringe

	2003	2004	2005	2006	2007	2008
Co. size (no. employees)	15,900	15,900	15,800	16,920	18,345	18,461
Sample size	921	965	1,336	1,834	2,187	1,504
Response rate (%)	5.8	6.1	8.5	10.8	11.9	8.1
Modal split:	(Unweighted) averages					
• **Car driver only**	68.3	66.7	66.1	67.3	66.9	66.3
• **Car sharing**	12.5	14.2	13.7	11.9	11.2	12.2
• **Walk**	4.2	4.8	5.8	5.5	5.3	5.5
• **Bike**	5.0	3.4	6.4	6.2	5.2	3.9
• **Bus**	2.6	2.5	2.4	1.8	2.4	3.0
• **Train**	5.8	5.7	2.7	4.9	5.4	4.9
• **Motorbike**	1.7	1.8	1.8	1.3	1.8	1.3
• **Work from home**	0	0	0	0.2	0.1	1.2
• **Other**	0	0.6	0	0.8	1.7	1.7

Source: South Gloucestershire Council

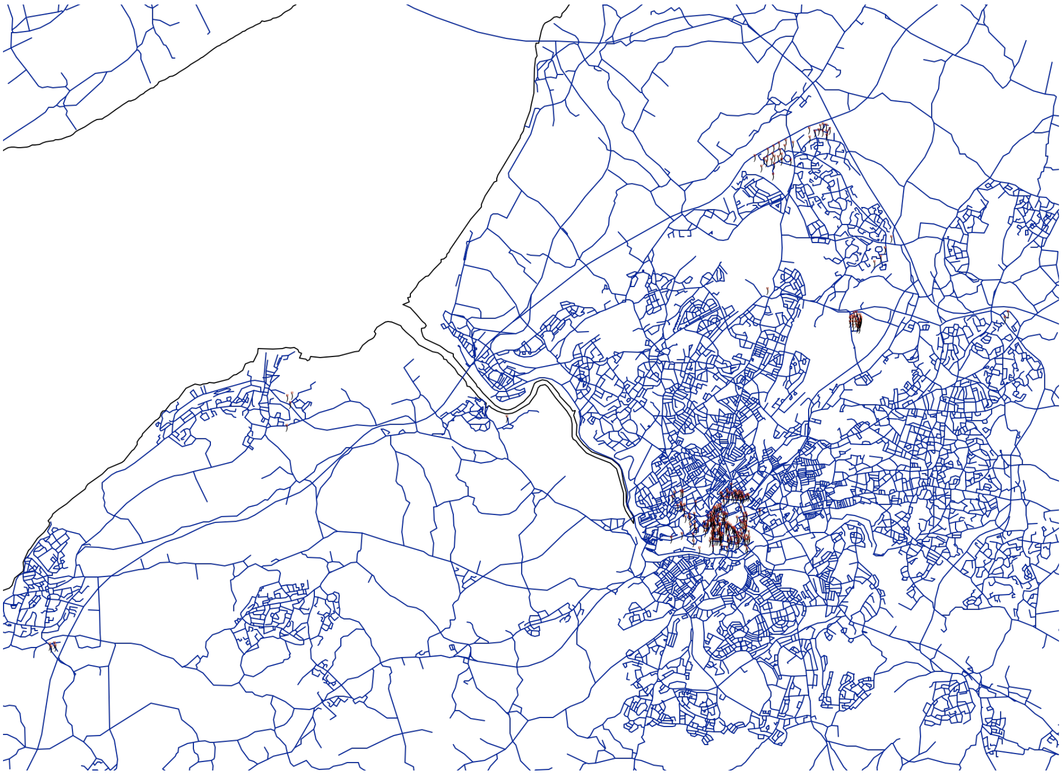
3. METHOD

This study focused on office space in buildings of 10,000 square feet or more that were constructed over the last 50 years in the metropolitan office market of Bristol in the UK. Property consultants King Sturge regularly publish details on city centre and out of town buildings of 10,000 square feet or more that have been built since 1956 and are currently used as office space[1]. The city centre sample contains 196 buildings that were constructed over the 52-year time period and that are still in use as office space. Out of town there are seven locations in which 32 business parks that have been developed since 1981. Table 5 provides a breakdown of the gross floor area of these buildings and figure 2 shows their locations.

Table 5: Gross floor-space (square metres)

	Naturally ventilated cellular	Naturally ventilated open-plan	Air-conditioned standard	Air-conditioned prestige	Sub-Total	Total
City Centre: Under 10 years		1,765	14,320	178,368	194,454	
City Centre: 10+ years	32,270	195,219	391,336	67,875	686,700	
CITY CENTRE						881,153
Out-of-town: Under 10 years		43,193	91,760		134,953	
Out-of-town: 10+ years		100,619	73,659	5,853	180,131	
OUT-OF-TOWN						315,084
TOTAL	32,270	340,796	571,075	252,096		1,196,238

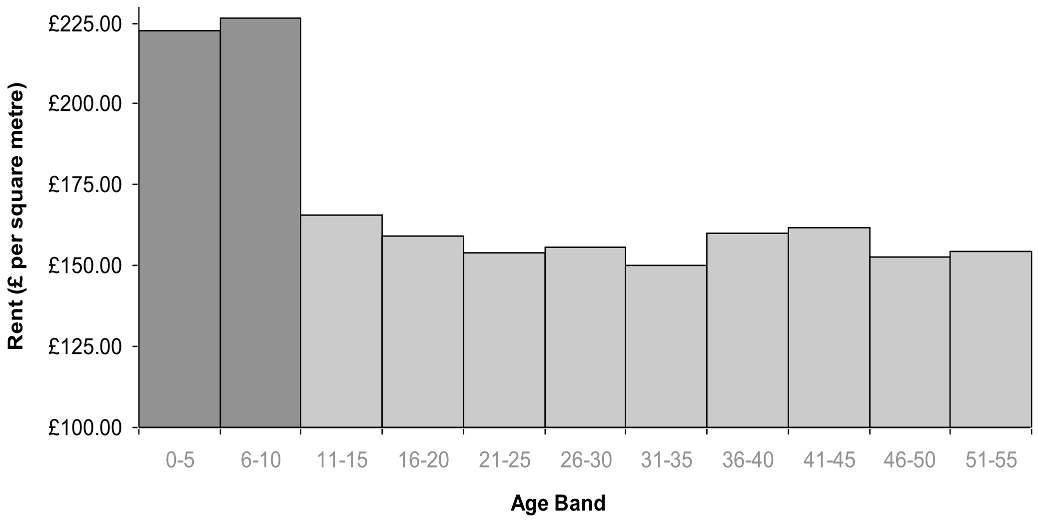
Figure 2: Office locations



With help of the King Sturge office agents each office building in the sample was assigned to one of the four office types defined in the Energy Consumption Guide 19 published by the Carbon Trust) and used in tables 1 and 2 above. 18 properties were classified as *Naturally Ventilated Cellular* (approximately 32,000 gross square metres or 3% of the sample), 98 properties were *Naturally Ventilated Open Plan* (341,000 gross square metres or 28%), 114 properties were *Air Conditioned Standard* (571,000 gross square metres or 48%) and 26 properties were *Air Conditioned Prestige* (252,000 gross square metres or 21%). Table 5 shows that in the city centre a high proportion of office space is air-conditioned whereas out-of-town the mix of naturally ventilated and air-conditioned space is much more balanced.

As reported in section two McAllister and Cyril Sweett (2007) found that energy consumption is significantly different depending on whether the office space is new or existing. The Bristol sample was therefore categorised as new or existing space by examining headline rents using data from Focus and Estates Gazette online databases, together with data from King Sturge. The resultant database contained a total of 376 records for 119 city centre properties. Figure 3 shows that there is a distinct drop in rents agreed in 2005 and 2006 depending on whether the office building was under or over ten years old. This 10-year threshold was therefore used to split the sample between new and existing space for the purposes of energy consumption analysis. 28% of office floor-space was ten years or younger and 72% of the stock was over 10 years old.

Figure 3: City centre rents (£/sqm) achieved 2005-6 classified by age (years)



4. RESULTS

4.1 Operational energy consumption and CO_2 emission

The Carbon Trust cites conversion ratios from gross to the actual treated floor space as being 95% of gross floor space for naturally ventilated cellular and open plan, 90% for air conditioned standard and 85% and for air conditioned prestige. This treated floor space was used to calculate energy use and CO_2 emissions by using the estimates that are given in table 2. The results can be seen in table 6.

Table 6: Energy use and CO_2 emission (using McAllister and Cyril Sweett figures)

		Naturally Ventilated Cellular	Naturally Ventilated Open Plan	Air-conditioned Standard	Air-conditioned Prestige
Energy use (kWh) x 1000	*City centre (0-10 yrs)*	-	218	2,835	68,226
	City centre (>10 yrs)	6,131	43,583	140,881	32,308
	Out of Town (0-10 yrs)	-	5,334	18,168	-
	Out of Town (>10 yrs)	-	22,463	26,517	2,786
	Total energy use	6131	71598	188402	103320
CO_2 emission ($kgCO_2$) x 1000	*City centre (0-10 yrs)*	-	18	268	7,528
	City centre (>10 yrs)	445	3,518	13,269	3,238
	Out of Town (0-10 yrs)	-	447	1,719	-
	Out of Town (>10 yrs)	-	1,813	2,498	279
	Total emissions	445	5796	17754	11045

Energy was converted into CO_2 using numbers from Energy Consumption Guide 19 (Carbon Trust 2000; 21). These numbers assume CO_2 emission factors of 0.052 kgC/kWh for gas and 0.127 kgC/kWh for electricity.

The biggest energy users and CO_2 emitters are air conditioned prestige offices, both in absolute terms and per unit of floor area. In relative terms they even emit more CO_2 than they consume in energy. The result for total energy use of the existing stock was placed along two spectra that range from a very sustainable 'low' (based on all office space in Bristol being newly constructed Naturally Ventilated Open plan, which uses the least energy and emits the least CO_2 of the available options) to a very unsustainable 'high' (based on the same amount of office space in Bristol being newly constructed Air Conditioning Prestige, which uses the most energy and emits the most CO_2 of the available options). The results are displayed in figures 4 and 5.

Figure 4: Energy comparison bar

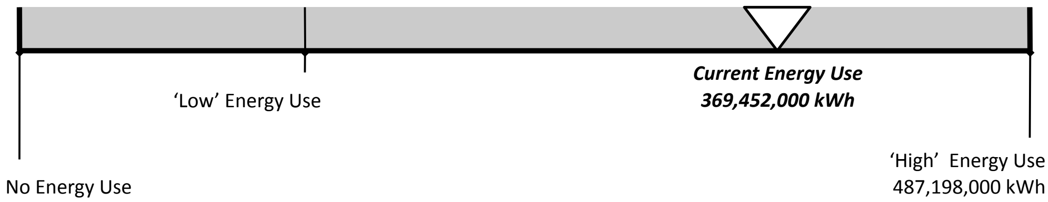
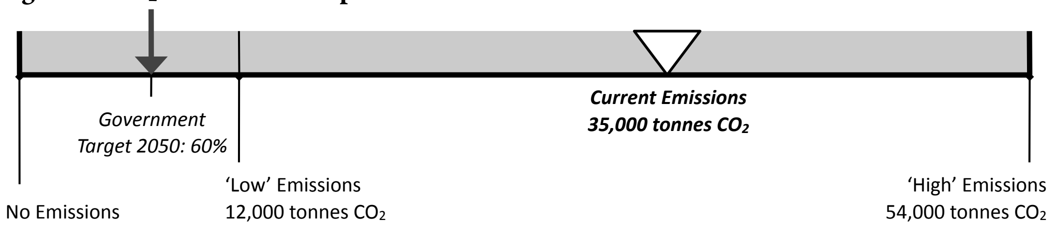


Figure 5: CO_2 Emissions comparison bar



Both in terms of energy use and resultant CO_2 emissions, the office stock in Bristol leans more towards the high end of both spectra. It is also possible to make an estimate of the annual CO_2 emissions per office occupant in Bristol by dividing the total CO_2 emissions (measured in kilograms) for offices over 10,000 sq ft in the Bristol study area by the total number of office occupants in Bristol. The latter was estimated by determining the total net floor area of office space in Bristol

The Carbon Trust (2000) states that the net lettable area is 80% of the treated floor space. This ratio was used to convert treated floor space into net lettable area. It also estimates that each office worker occupies 10 square metres of net lettable area. So, assuming a 0% vacancy rate, it is estimated that, on average, each office worker emits 405 kg of CO_2 each year.

4.2 Transport-related energy consumption and CO_2 emission

Table 7 shows the distances travelled per person per year for commuting/ business, in England (Department for Transport, 2006: Table 7.2). Using national figures from the Department of Transport (2007) that report the modal split for commuters together with emissions data from the National Atmospheric Emissions Inventory which report the amount of CO_2 emitted by each mode, it is possible to calculate an average CO_2 emission per person per year for commuting/business travel which is weighted by distance travelled by each mode. The weighted average CO_2 emission is 276 kg per occupant per year, approximately two thirds of the CO_2 emission resulting from building operation reported in section 4.1 above. For the South West region the emission figure was 298 kg per occupant per year: the regions outside of London and the South East tend to have higher proportions of car-based commuting.

Table 7: Commuting / business travel-related CO_2 emission

Mode	Proportion of commuters: England	Proportion of commuters: South West	Distance travelled per person per year (km)	CO_2 emission (kg/km/person)	CO_2 emission (kg/person) weighted by distance travelled by each mode
Car driver	70%	76%	2,285	0.1710	273.51
Car passenger	-	-	304	0.0855	-
Bus	7%	5%	109	0.0762	0.58
Train	7%	2%	439	0.0486	1.49
Motorcycle	1%	1%	26	0.0872	0.02
Cycle/walk	14%	16%	51	0.0000	0.00
Source:	*DfT 2007*		*DfT 2006*	*National Atmospheric Emissions Inventory*	Weighted average = 275.6

In section two, it was argued that the location of office space has a significant impact on modal split and consequently on CO_2 emissions. In order to examine whether such an impact was discernable in the Bristol office data set, the location of office space in Bristol was classified as either city centre or out-of-town and respective emissions were compared using data obtained from Bristol City Council and Orange travel surveys. Using the same approach as that described for the national data in table 7, weighted average emission figures were calculated using modal split percentages for the South West (Department for Transport, 2007), for Bristol city centre and for Bristol out-of-town office locations. Table 8 shows the data and the weighted average regional, city centre and out-of-town emissions figures are:

- Bristol city centre 114 $kgCO_2$/person/year
- Bristol out-of-town (South Glocs data) 262 $kgCO_2$/person/year
- Bristol out-of-town (Orange plc data) 311 $kgCO_2$/person/year

Table 000: Travel-to-work mode and distance

Mode	Bristol city centre[1]	Bristol out of town	Bristol out of town	Distance travelled (km)	CO_2 emission (kg/km/ person)
Car/van/minibus	27%	66%	79%	2,285	0.1710
Car/van/minibus passenger	11%	12%	7%	304	0.0855
Bus	27%[2]	3%	7%	109	0.0762
Train	17%	5%	0%	439	0.0486
Motorcycle	4%	1%	2%	26	0.0872
Cycle / walk	19%	9%	6%	51	0.0000
Source:	*Bristol City Council and Orange plc*	*South Glocs Council*	*Orange plc*	*DfT 2006*	*National Atmospheric Emissions Inventory*

[1] Averages of figs for four offices in Temple Quay area of Bristol so do not add up to 100%
[2] Includes P&R so journeys may well include car as part of multi-mode trips

Looking at the weighting BREEAM gives to energy and transport criteria: in 2006 28% of the available credits were energy-related and 21% transport-related. In 2008 these weightings changed substantially to 21% and 8% respectively. Furthermore, of the transport credits available 71% in 2006 and only 40% in 2008 are dependent on location. This means that in 2008 only 3% of total BREEAM credits are available for choosing a location that seeks to reduce commuting-related CO_2 emission. This is a substantial drop from the 15% that was available in the 2006 version of BREEAM. And this 3% contrasts with the 15% of total credits available for reduction of CO_2 emissions associated with operational energy consumption; a weighting that is five times greater, and one that increased from 12% in the 2006 version. Given the amount of CO_2 emitted as a result of commuting/business travel, this seems rather low.

5. CONCLUSIONS

BREEAM 2006 awards up to 15 credits for percentage improvements in a building's energy efficiency of 70% or more over the requirements of Approved Credits Document Part L2A New Buildings other than dwellings 2006. However, no numbers are quoted that allow for a direct comparison between the per occupant CO_2 emissions found in this research and BREEAM requirements. BREEAM 2008 uses the building's EPC rating as a basis. The higher the rating, the more efficient the building is.

The transport-related emissions figures are all below the minimum BREEAM 2006 assessment threshold of 400 kgCO_2 per worker per year, so they all score the maximum of 10 credits.

On the whole, the office stock in Bristol does not perform very well in terms of energy use or CO_2 emissions. This view emerges from the classification that is used here and it should be noted that these findings are sensitive to the way in which the stock is categorised. Many of the high energy use and consequent CO_2 emission figures can be attributed to the widespread use of air-conditioning systems which consume a great deal of energy. A typical prestige air-conditioned office emits three to four times as much CO_2 per unit of floor area as a typical naturally ventilated cellular office or 2.3 to 3 times as high if computer room energy is not taken into account (Wade *et al*, 2003). The use of air-conditioning systems can be traced back to a change in institutional specifications since the 1970s. As Guy (1998) wrote: "[o]riginally fashioned for specific user requirements, this 'intelligent specification' came to represent and reinforce institutionally acceptable 'prime' standards. This further encouraged the use of full air-conditioning in locations in which it would otherwise be unnecessary." Judging by the high proportion of air-conditioned office space, Bristol has been clearly affected by this trend, although less so in out-of-town locations. The introduction of energy performance certificates (EPCs) will mean that buildings will be classified according to type of energy use and emissions and this will make the market for energy efficient and energy inefficient property much more transparent. But EPCs treat the presence of air-conditioning as a given and measure their efficiency rather than the actual necessity for them.

The extent to which a property generates and relies upon carbon-based transport is significant to its environmental performance. The results show that there is a significant difference in the amount of CO_2 emitted by commuters to city centre and out-of-town office locations. The more sustainable solution is clearly proximity to public transport node(s). As Orange stated "[t]he experience of Orange is particularly dramatic in demonstrating the locational advantages of a town centre" (DfT, 2005) and the Department for Transport concludes in that report: "[o]rganisations in out-of-town locations are likely to have more difficulty in achieving low levels of car use. The example of Orange … shows how much easier it is to encourage a change in travel habits at a central location" (DfT, 2005). It is important to consider environmental performance beyond simply the operation of the building itself. In the future, increasing objections to road-building, out-of-town development and unrestrained vehicle use may influence the location and use of buildings and locations that generate increased road traffic may fall out of favour. Haig (1926) used the phrase 'friction of space' to describe the way occupiers seek to minimise economic transport costs when choosing a location. A similar notion might be used to describe how occupiers may seek to minimise environmental transport costs in the future.

REFERENCES

Bordass, B. (2000) Cost and value: fact and fiction, *Building Research & Information*, **28** (5/6), 338-352

Carbon Trust (2000) *Energy consumption guide 19: Energy use in offices* http://www.cibse.org/pdfs/ECG019.pdf

Cole, R. and Kernan, P. (1996) Life-cycle energy use in office buildings. *Building and Environment*, **31** (4), 307-317

Department for Transport (2005) *Making travel plans work: lessons from UK case studies*, Department for Transport, London

Department for Transport (2006) *National Travel Survey,* Transport Statistics: Department for Transport, London

Department for Transport (2007) *Transport Statistics Great Britain, 2007 Edition*, National Statistics & Department for Transport, London

Guy, S. (1998) Developing Alternatives: Energy, Offices and the Environment. *International Journal of Urban and Regional Research*, **22** (2), 264-282.

Haig, R. M. (1926) Towards an understanding of the metropolis. *Quarterly Economic Journal*, **40**, May, 421-3

IPF (2005) Understanding Commercial Property Investment: A Guide for Financial Advisers - 2005 Edition, Investment Property Forum http://www.rics.org/NR/rdonlyres/47DA7856-4B97-4DAB-AFD8-C80E175DD8D0/0/IPFfinancialguide05.pdf

Keeping, M. and Shiers, D. (1996), The Green Refurbishment of Existing Property. *Facilities*, **14** (3/4), 15–19

McAllister, I. and Cyril Sweett (2007*) Transforming existing buildings: the green challenge, Final Report, March*, Royal Institution of Chartered Surveyors / Cyril Sweett, http://www.rics.org/NR/rdonlyres/381CCB81-EF08-45B9-B42C-547335E0ABF20/0/TransformingExistingBuildingsTheGreenChallenge.pdf

ODPM (2006) *Commercial and industrial floorspace and rateable value statistics 2005, (2005 Revaluation)*, Office of the Deputy Prime Minister, London

Titheridge, H. and Hall, P. (2006) Changing travel to work patterns in South East England. *Journal of Transport Geography*, **14**, 60-75

Wade, J., Pett, J. and Ramsay, L. (2003) *Energy efficiency in offices: assessing the situation*, The Association for the Conservation of Energy, London

ACKNOWLEDGEMENTS

The research on which this paper is based is part of a two-year study that is being funded by King Sturge Property Consultants and the University of the West of England. The authors are very grateful for the support of staff at the Bristol office of King Sturge who have supplied data and expertise throughout the project.

NOTES

[1] ‘Bristol City Centre Office Developments’ and ‘Bristol Business Park developments’, both updated annually

The role of parametric modelling and environmental simulation in delivering sustainable healthcare buildings

Emeka Efe Osaji, Prof Andrew Price

Loughborough University, UK

There is a need for innovative strategies capable of facilitating the delivery of sustainable healthcare buildings that successfully achieve healthy, comfortable internal conditions while minimising the environmental impacts on building operation. The National Health Service (NHS) has recognised that it has a responsibility to pioneer efforts in the climate change agenda for the benefit of its healthcare building users, including patients and the general public. The significance of the impacts of climate change on NHS healthcare buildings is evident by the fact that the NHS carbon footprint in England is estimated to be in the region of 18 million tonnes of carbon dioxide annually, which represents approximately 3% of England's total carbon emissions. Annual energy expenditure by the NHS is currently over £429 million for electricity and heating which represents approximately 22% of the NHS England total carbon footprint. Factors that may have a negative impact leading to an increase in NHS carbon dioxide emissions include: an increase in the energy intensity of its healthcare delivery; an increase in floor area due to progress in its major building programmes; and an increase in its total activity due to demographic changes. In support of the NHS's sustainable goals and aspirations for carbon reduction and a more energy efficient healthcare building stock, parametric modelling and environmental simulation has been identified to play a key role in building energy performance assessment. This paper offers an understanding of how parametric modelling and environmental simulation can be applied for the energy efficient design of new healthcare buildings, and the energy performance assessment of existing healthcare buildings. The issue of building energy performance is important and the integration of building energy performance assessment – particularly during the new build design stage – is capable of overcoming the barrier to accessing the building energy efficiency resource potential, thereby facilitating improvement in low-energy new building design. Such an improvement could translate to a 50-75% reduction in energy consumption levels. Its implications include: a significant reduction in energy costs; contribution to the mitigation of environmental impacts and climate change; and alleviation of occupancy discomfort. This paper has reviewed current literature – and an assessment tool and method – related to parametric modelling and environmental simulation. Its possible applicability to healthcare environmental design was reviewed to identify examples of good practice, evidence-based solutions and the conceptualisation of a Virtual Health Promoting Environment (VHE) that integrates such a key assessment method for efficient building performance. It was discovered that parametric modelling and environmental simulation support building energy simulation analysis as a building energy performance assessment method that overcomes the barrier caused by ineffective decision-support. It has an important role to play in delivering sustainable healthcare buildings by facilitating: a strengthening of the evidence base of environmental impacts; the development of innovative solutions; effective integration and collaborative working between teams; and consensus building and collective decision making with multiple stakeholders.

Keywords: assessment methods, energy efficiency, environmental simulation, parametric modelling, sustainable buildings

INTRODUCTION

The National Health Service Sustainable Development Unit (NHS SDU) (2008) has identified that the environment and climate change impact significantly on healthcare building energy performance. Its statistical evidence shows that the NHS England annual carbon footprint is estimated to be about 18 million tonnes of CO_2 which accounts for nearly 3% of England's total carbon emissions. Also, the NHS annual energy expenditure exceeds the £429 million mark – which includes for both electricity and heating – and this accounts for nearly 22% of its total carbon footprint. It is possible that in order to achieve sustainable healthcare buildings, the use of an appropriate approach for assessing, evaluating and validating their energy performance – at both the pre-occupancy and post-occupancy stages – (w)could offer potential in mitigating these environmental and climate change impacts. A building energy performance assessment approach that offers such potential is parametric modelling and environmental simulation.

The study disseminated in this paper is aimed at facilitating the identification and description of the relevant features and capabilities inherent in the parametric modelling and environmental simulation approach. The central methods used for data collection and analysis include the following:

- the use of state-of-the-art literature reviews: for the presentation of the features and capabilities of the parametric modelling and environmental simulation approach, as well as the context that necessitates its application; and
- the use of case study research and scenario reporting: for the investigation, identification and collation of evidence of good practice in the application of the parametric modelling and environmental simulation approach. The resultant information will be used to develop an integrated strategy that facilitates energy efficient design of new, and the energy performance assessment of existing healthcare buildings.

According to Clarke (2001), pre-occupancy and post-occupancy building energy performance assessment is important, and the integration of this as a strategy – particularly during the new build design stage – is capable of improving low-energy building design by nearly a 50-75% reduction in energy consumption levels. This paper has identified – through review of relevant literature, case studies and scenarios – that the parametric modelling and environmental simulation approach has a significant role to play in delivering sustainable energy efficient healthcare buildings. It (w)could achieve this by facilitating: a strengthening of the evidence base of the impacts of multiple variable environmental parameters; mitigation of environmental impacts and the effects of climate change; the development of sustainable design solutions; effective integration and collaborative working between various professional teams; consensus building and collective decision making with various stakeholders; a significant reduction in energy consumption and expenditure; and an alleviation of occupancy discomfort.

Based on a review of literature related to building energy performance assessments methods that was undertaken by Osaji (2008) and this paper, two methods were identified and these are the: building energy consumption audit method; and building energy simulation analysis method.

BUILDING ENERGY PERFORMANCE ASSESSMENT METHODS

Flex Your Power (2007) recommends that the ideal process by which to undertake an assessment and determination of a building's energy performance is to: track its energy profile over a specific period; establish baseline data; and then undertake a comparative study and benchmarking of its energy performance results. This is important because a building's potential energy savings is difficult for facility managers to establish without the establishment of an energy performance baseline. Further, there are two primary ways whereby baseline data can be established, as well as building energy performance assessed. These are:

1. the energy consumption audit method: this involves the use of an energy audit system for the analysis of historical energy use that takes into consideration: operational modifications; climatic extremities; and other factors (parameters and variables) that affect building energy consumption and expenditure; and
2. the building energy simulation analysis method: this requires the modelling of building energy consumption – also known as calibrated simulation – and it also involves the use of complex computer software for the prediction of building energy performance.

THE BUILDING ENERGY CONSUMPTION AUDIT METHOD

As previously stated, one of the two building energy performance assessment methods identified by this paper is the building energy consumption audit method. Its significance lies in its requirement for the establishment of baseline energy consumption data, which thereby facilitates the assessment of building energy performance. It also involves building historical energy consumption analysis, as well as the analysis of other factors that are capable of influencing its energy expenditure.

One scenario that is responsible for the issue of building occupancy discomfort is the occasional occurrence of inconvenient indoor thermal conditions. The need for the resolution of such a scenario is one of the justifications for the adoption of sustainable building energy efficiency and energy conservation measures. The building energy consumption audit method has the capability of tracking building energy performance and comparing this to baseline data for the detection and determination of problematic scenarios – such as those associated with the malfunction of cooling and/or heating equipment and other related occurrences – that could result in unexpected energy demand surges.

Complementary to the building energy consumption audit method characteristics already mentioned – such as those associated with the assessment of building energy performance against a baseline – benchmarking is another characteristic that can also be used for comparative analysis against attributes, including climate, size, operations, and age. Benchmarking provides an opportunity for a building's historical energy performance to be assessed through a statistical comparison with best practice guidelines, regulations and projections in order to achieve energy efficiency.

Apart from the building energy consumption audit method, another building energy performance assessment method is the building energy simulation analysis method.

THE BUILDING ENERGY SIMULATION ANALYSIS METHOD

The importance of building energy performance assessment is evident in Clarke (2001) where it acknowledges that the integration of building energy performance assessment – particularly during the new build design stage – has the capability of overcoming the barrier to accessing the energy efficiency resource potential. This facilitates an improvement in low-energy building design. The anticipation and aspiration is that such an improvement (w)could translate into an energy consumption reduction – by as much as 50-75% – that is relative to year 2000 levels. The implications of this include: a significant reduction in state energy costs; contribution to the principles of sustainable building design through the mitigation of environmental impacts and the effects of climate change; and alleviation of building occupancy discomfort.

The recommendation by Clarke (2001) is that building energy simulation analysis as a building energy performance assessment method is appropriate because of its capability to overcome the earlier mentioned barrier that is caused by ineffective decision-support. The building energy simulation analysis method overcomes this barrier by facilitating:

- a strengthening of the evidence base of environmental impacts and the effects of climate change;
- the development of innovative solutions that promote sustainable building design;
- the efficient integration and collaborative working between teams; and
- a building of consensus and collective decision making with multiple stakeholders courtesy of an improved evidence base.

The benefits of the building energy simulation analysis method is evident in its facilitation of the appraisal of varied energy demand reduction options, best and sustainable practices, and the performance and associated cost of alternative design approaches (Clarke, 2001). Also, heating and energy environmental systems are of particular importance to the environmental analyses tasks performed by building energy simulation analysis programs (Szalapaj, 2001). Further, Szalapaj (2001, p.31) indicates that "thermal analysis ranges from simple U-value calculations, through to complex simulations that dynamically model thermal properties".

Twenty major building energy simulation analysis programs are identified by Crawley et al. (2005), and these are: BLAST; Bsim; DeST; DOE-2.1E; ECOTECT;

Ener-Win; Energy Express; Energy-10; EnergyPlus; eQUEST; ESP-r; IDA ICE; IES <VE>; HAP; HEED; PowerDomus; SUNREL; Tas; TRACE; and TRNSYS. The Building Research Establishment (BRE) (2008) also describes two other simulation programs, and these are the National Calculation Method (NCM) and Simplified Building Energy Model (SBEM), and its user interface – iSBEM. However, after a study of the review of these twenty-two building energy simulation analysis programs, ECOTECT was identified by this paper to possess appropriate features and capabilities that promote and support parametric modelling and environmental simulation.

THE ECOTECT PARAMETRIC MODELLING AND ENVIRONMENTAL SIMULATION TOOL

The parametric modelling and environmental simulation approach can be described as the use of object oriented CAD for the modelling and simulation of components – within multiple real-world behaviours and environmental parameters – in order to assess, evaluate and validate design solutions and 'what-if' scenarios. As earlier stated, a retrospective review – by this paper – of literature related to twenty-two major building energy simulation analysis programs identified ECOTECT as one tool that appropriately supports the parametric modelling and environmental simulation approach, which in turn supports sustainable building design principles.

According to Crawley et al. (2005, p. 232), "ECOTECT is a highly visual architectural design and analysis tool…". Its capability links multiple performance analysis functions to an advanced 3D editor and modeller. Its multiple performance analysis functions include thermal, energy, lighting, shading, acoustics and cost aspects. Its 3D editing, modelling, and visualisation capabilities are advanced enough to incorporate varying degrees of volumetric and analytical complexities. Also, its volumetric and spatial analysis results can be visualised while real-time animations can be generated to demonstrate updates and modifications to the building's response to its location, climate, and operational hours' characteristics. Further, ECOTECT provides the opportunity for obtaining important performance feedback during the earliest stages of the building design process. It displays analytical results as standard graph and table based reports, however, such results can also be mapped over the building surfaces and within their spaces.

During studies involving the use and review of ECOTECT, this paper discovered it to be a highly visual and interactive tool (refer to table 1) that supports:

- parametric modelling and environmental simulations;
- performance analyses that covers thermal, energy, lighting, shading, acoustics, resource use, and cost aspects within multiple environmental parameters and variables;
- mapping of analyses results over the parametric building model surfaces and within its single and/or multiple zone spaces;
- compatibility with other programs and tools, including EnergyPlus, Radiance, NIST FDS and ArchiCAD; and

- evidence-based design improvements.

Table 1 The Identified Building Energy Performance Simulation Program

Identified Building Energy Performance Simulation Program	Reasons
ECOTECT building design energy performance simulation analysis program	▪ It supports parametric modelling and environmental simulations; ▪ It is a highly visual and interactive building design and analysis tool; ▪ It links a comprehensive 3D modeller with a wide range of performance analysis functions; ▪ It supports performance analysis that covers thermal, energy, lighting, shading, acoustics, resource use, and cost aspects within multiple environmental parameters; ▪ It supports the mapping of analysis results over building surfaces and within spaces; ▪ It supports compatibility with EnergyPlus, Radiance, NIST FDS and ArchiCAD; and ▪ It supports evidence-based design improvements, as well as innovative solutions for sustainable building design.

RETROSPECTIVE CASE STUDY REVIEW OF THE PARAMETRIC MODELLING AND ENVIRONMENTAL SIMULATION APPROACH AND APPLICATION OF ECOTECT

This paper undertook a retrospective case study review of the parametric modelling and environmental simulation approach and the application of ECOTECT. It was identified by this paper that – in Osaji (2008) – ECOTECT was used for the post-occupancy environmental performance assessment, evaluation, and validation of two commercial buildings with similar morphologies and climatic conditions, but with varying height and volumetric specifications. ECOTECT was employed for the implementation of the parametric modelling and environmental simulation approach for the study of the impacts of multiple variable environmental parameters on these case study buildings' thermal energy performance. This process involved three stages:

- initially, case study research was used for the establishment of good practice environmental design details, and for energy consumption audits that were aimed at the establishment of baseline data. This involved the use of an energy audit system for the analysis of historical energy use, including for both consumption and expenditure data for a particular financial period. These took into consideration: operational modifications; climatic extremities; and other key environmental parameters and variables that were identified – during the case study research – to have influenced these buildings' energy use and costs;

- subsequently, environmental performance benchmarking of the audited secondary data was undertaken against industry best practice standards. Benchmarking was used for the comparative analysis of the derived energy audit data against parameters that include: climate; size; operations; and age. The benchmarking process provided an opportunity for the case study buildings' historical energy performance to be assessed through a statistical comparison with best practice guidelines, regulations and projections – such as those of the DETR (2000b) in Wade et al. (2003) – in order to achieve energy efficiency; and
- eventually, simulation-based research – involving the use of ECOTECT for parametric modelling and environmental simulations – was undertaken for the study and analyses of the impacts of multiple environmental parameters and variables, and enablers on the energy performance of the case study buildings' single and multiple zones. This was done in order to generate primary data of predictive case study building environmental performance. The use of ECOTECT for this simulation-based research involved environmental simulations of created parametric models (comprising single and/or multiple zone volumes), which were of similar volume and morphology specifications to the case study buildings.

The environmental simulations of these parametric volumetric models was undertaken for the determination: of the impacts of multiple variable environmental parameters on the case study buildings' thermal energy performance; and the enablers to a sustainable building design that facilitates thermal energy efficiency.

These parametric modelling and environmental simulations were defined and governed by the following developed rule set of selected parameters and variables:

- building morphology: in terms of the building form as a focus, but also in comparison to similar multiple variable building forms;
- thermal properties: in terms of the type of HVAC system (for instance, full air conditioning versus a mixed-mode system), comfort band (lower band and upper band), occupancy (the number of people occupying the building and their activity(ies)), internal gains (sensible gain and latent gain), and infiltration rate (air change rate and wind sensitivity);
- building type: in terms of the particular building typology, which was defined by its scale and function;
- site location: in terms of climate zones (for instance, temperate (UK-London, etc.) and tropical (West Africa-Lagos, etc.)), site specifics (north offset, altitude and local terrain), latitude, longitude and local time zone(s));
- building volume: as defined by similar that was identified in the case study buildings in terms of height specifications of x metres (m) and y metres (m)), and volume specifications of x m^3 and y m^3 (where x m = case study building 1's height and y m = case study building 2's height while x m^3 = case study building 1's volume and y m^3 = case study building 2's volume);

- hours of operation: in terms of the case study buildings' weekly staff and public access, as well as their duration of stay and use;
- design conditions: in terms of the clothing, humidity, air speed and lighting levels and conditions; and
- building materials: in terms of the glazing and non-glazing materials, and the U-Value and admittance level.

SOME HEALTHCARE BUILDING SCENARIOS CAPABLE OF BEING ASSESSED, EVALUATED AND VALIDATED USING THE PARAMETRIC MODELLING AND ENVIRONMENTAL SIMULATION APPROACH

Parametric modelling and environmental simulation can be used for the modelling and simulation of components – within multiple real-world behaviours, environmental parameters and variables – in order to assess, evaluate and validate sustainable building design solutions and 'what-if' scenarios. Parametric modelling and environmental simulation's capability to assess, evaluate and validate 'what-if' scenarios is key to the fulfilment of sustainable design principles in both new healthcare buildings, as well as existing ones, including those being subjected to refurbishments.

Scenario 1:

For instance, one 'what-if' scenario that can be assessed, evaluated and validated through the use of the parametric modelling and environmental simulation approach is the proposal for the inclusion of more single room accommodation in new hospital building designs. What impact (w)could this have on their building services and occupancy comfort – such as on energy consumption, performance, and thermal comfort – and how can the parametric modelling and environmental simulation approach facilitate the inclusion of sustainable design principles while fulfilling the single room healthcare building accommodation scheme?

Even though the proposal for single room healthcare building accommodation has potential benefits, it should be noted it also raises certain sustainability related issues that require consideration. A key research question that parametric modelling and environmental simulation is capable of exploring is: how can single room healthcare building accommodation be designed in order to minimise material cost, as well as enhance the patient stay in terms of occupancy comfort such as thermal comfort? The more the interior walls, subdivisions or partitions that are set-up to create single rooms, the more there is a necessity to consider cost and energy use implications.

Parametric modelling and environmental simulation – through improvement in the evidence base of environmental impacts and the effects of climate change – could also address the choice of an appropriate type of ventilation strategy and control that is appropriate for single room healthcare building accommodation.

Options include centralised or decentralised ventilation strategies, which could also be independently controlled or otherwise?

Apart from supporting the decision making process – through an improved evidence base – for selection of an appropriate ventilation strategy and control, parametric modelling and environmental simulation also applies a similar approach for facilitating the selection of an appropriate lighting strategy. The development, choice and application of a suitable lighting strategy is challenging when conceptualising single room healthcare building accommodation. Parametric modelling and environmental simulation is capable of investigating various lighting strategies in order to determine the most appropriate for single room healthcare building accommodation while maintaining adequate patient-bed layout.

The building services that feed such single room healthcare building accommodation – and consequently impact on patient, staff and visitor comfort – is important. A 'before' and 'after' scenario that the parametric modelling and environmental simulation approach is capable of investigating includes the following: what is – if any – the difference in building service performance between a single room healthcare building accommodation and an open plan style ward of similar spatial volume specification? Also, does an(y) increase in multiple zones within a single zonal volume impact on the healthcare building service performance, including on its lighting, HVAC, and energy use? Further, for each single room added to a healthcare building accommodation, by how much (scheme requirement(s), expenditure and consumption) does it affect the overall building service performance and compliance with sustainable building design principles and targets?

Scenario 2:

The NHS in England has an annual carbon footprint that is estimated to be about 18 million tonnes of CO_2. This accounts for nearly 3% of England's total carbon emissions. The NHS annual energy expenditure also exceeds £429 million – and this includes both electricity and heating – which accounts for nearly 22% of its total carbon footprint (NHS SDU, 2008).

A key 'what-if' scenario that can be assessed, evaluated and validated by parametric modelling and environmental simulation is: how can such an approach contribute to meeting and probably even exceeding the national target that has been proposed to reduce NHS carbon emissions by 60% by the year 2050?

CONCLUSION: THE ROLE OF PARAMETRIC MODELLING AND ENVIRONMENTAL SIMULATION IN DELIVERING SUSTAINABLE HEALTHCARE BUILDINGS

This paper has determined that parametric modelling and environmental simulation has an important role to play in delivering sustainable healthcare buildings that are energy efficient both in design and performance. It does this by facilitating:

- evidence-based design through a strengthening of the evidence of impacts within multiple variable environmental parameters;
- the development of sustainable building design solutions for the mitigation of environmental impacts and the effects of climate change;
- effective integration and collaboration between professional teams, and consensus building and collective decision making with various stakeholders; and
- a reduction in energy consumption, expenditure, and occupancy discomfort.

ECOTECT has also been determined by this paper to be a suitable building energy simulation analysis program possessing capabilities and features that support parametric modelling and environmental simulation for assessment, evaluation and validation of sustainable healthcare building design solutions and 'what-if' scenarios. ECOTECT is a highly visual design and analysis tool with the capability to link multiple – thermal, energy, lighting, shading, acoustics and cost – performance analysis functions to an advanced 3D modeller and editor. It permits spatial and volumetric analyses, as well as real-time animations that reflect modifications to a building's responsiveness to parameters that include: location; climate; and operational hours. Further, ECOTECT offers important performance feedback, including during the earliest stages of the healthcare building design process.

These capabilities and features suggest research benefits (refer to table 2) that indicate the role of parametric modelling and environmental simulation in delivering sustainable healthcare buildings.

Table 2 Parametric Modelling and Environmental Simulation Research Benefits

BENEFICIARIES	POTENTIAL BENEFITS ARISING
Healthcare building	▪ Performance analysis covering thermal, energy, lighting, shading, acoustics, resource use, and cost aspects within multiple environmental parameters. ▪ Evidence-based design improvements.
Service users (healthcare building occupants: staff; management; and visitors)	▪ Optimisation of building performance for improved thermal comfort. ▪ Improved work environments for occupancy comfort and staff productivity. ▪ Improved knowledge of enablers that support care promoting environments.
Practitioners (architects and engineers)	▪ Parametric modelling for evidence-based design. ▪ Mapping of analysis results over building surfaces and within spaces. ▪ Compatibility with EnergyPlus, Radiance, NIST FDS and ArchiCAD.
Academia	▪ Evidence of environmental impacts that provide new research opportunities for investigation into their implications for low-energy building design. ▪ Evidence of building optimisation for education and training of practitioners.

(Clark, 2001; Crawley et al., 2005; Marsh, 1996 and 2006; and Szalapaj, 2001)

REFERENCES

BRE. (2008) National Calculation Method. Building Research Establishment Ltd. Available at: http://www.ncm.bre.co.uk/

Clarke, J.A. (2001) Energy Simulation in Building Design 2nd Edition. Oxford: Butterworth-Heinemann.

Crawley, D.B., Hand, J.W., Kummert, M. and Griffith, B.T. (2005) Contrasting the Capabilities of Building Energy Performance Simulation Programs Joint Report Version 1.0. Proceedings of the International Building Performance Simulation Association 2005 Montreal, August 15 – 18, p. 232.

Department of the Environment (DOE). (1996) The Benefits of Including Energy Efficiency early in the Design Stage – Anglia Polytechnic University. Watford: Building Research Establishment Conservation Support Unit (BRECSU).

DETR. (2000b) Energy Efficiency Best Practice Programme Energy Consumption Guide 19 – Energy use in offices. London: Department of the Environment, Transport and the Regions.

Flex Your Power. (2007) Planning an Energy Program: Assessing Energy Performance. Best Practice Guide: Commercial Office Buildings. Available at: http://www.fypower.org/bpg/module.html?b=offices&m=Planning_an_Energy_Program&s=Assessing_Energy_Performance

Marsh, A.J. (1996) Integrating Performance Modelling into the Initial Stages of Design, in ANZAScA Conference Proceedings, Chinese University of Hong Kong, 1996.

Marsh, A.J. (2006) ECOTECT meets ArchiCAD. Available at: http://www.squ1.co.uk/node/1585

NHS SDU. (2008) Saving Carbon, Improving Health: A Draft Carbon Reduction Strategy for the NHS in England – a consultation document. National Health Service Sustainable Development Unit.

Osaji, E.E. (2008) A Study of the Impacts of Multi-Variable Environmental Parameters on the Thermal Energy Performance of the Prolate-Like Spheroid Tall Office Building Morphology. Ph.D thesis, University of Salford (Expected 2009).

Szalapaj, P. (2001) CAD Principles for architectural design: analytical approaches to computational representation of architectural form. Oxford: Architectural Press.

Wade, J., Pett, J. and Ramsay, L. (2003) Energy efficiency in offices: assessing the situation. London: Association for the Conservation of Energy.

Wade, J., Pett, J. and Ramsay, L. (2003) Energy efficiency in offices: motivating action. London: Association for the Conservation of Energy.

Sustainable building production in practice and in education

Assoc. Prof. Lars-Ãke Mikaelsson

Mid Sweden University, Sweden

Sustainable building is a very important aspect of sustainable development. It impacts on all three of the major areas of sustainability, namely environmental, economic and socio-political sustainability. The paper Sustainable Building Production in Practice and Education is a presentation of current research with the focus on the integration of sustainability in the building process. All stages in the process are considered but the main focus is the production phase, which also includes the projecting and production planning stages.

The paper is mainly a statement of research and development projects carried out at the Building Department at Mid Sweden University within the framework Sustainable Building Production.

The education of building engineers is one of the major issues in changing the building industry, and in moving it towards sustainable building. Not only the contents but also the pedagogical forms and teaching methods are of importance.

The results from the projects Project planning, work organization and leadership on the building site and Sustainable Wooden Houses indicate that wooden houses are comparably healthy using the formulated criteria. There is also a need for improvement of the production planning process. Wooden house building could be the catalyst for the industrialization of the building process, with improvements in the working environment, more effective production planning, work organisation and leadership.

The results of the project Flexible engineering education show that it is possible to combine campus-based courses which means that you can reach new target groups for education in sustainable building.

Future development work will have to provide more focus on learning and less on teaching. Sustainable building is a way of thinking that has to be integrated into the entire course program. It should be based on both theoretical and practical experience and the dissemination of good examples.

The results from all the projects will be used to improve education in building production for the building engineering programs at university level. The transformation of research results into educational material is still under development.

Keywords: higher education, sustainable building

Production Planning, Work Organization and Leadership on the Building Site

This paper is a presentation of the PAL-project (Production planning, work organization and leadership on the building site) [6] [18]. The aim of the project is to analyze the relationships between the factors of production planning, work organization and leadership on the building site in order to clarify the criteria that are characteristic of good work and healthy workplaces. The project is based on theories from previous projects in the field [1] [2] [3].

A well planned building site, appropriate schedule and good organization are the preconditions for high productivity and a good working environment whilst building, and they also lead to a finished product of good quality. When a building site is set up, and as each phase begins, a range of conditions is established, sometimes more and sometimes less consciously, which determine whether the workplace will function well or not. Something unique to the building trade is that the construction and adaptation of the work organization and the arrangement of the site take place at the same time, and each affects the other plus the fact that there is only "one" chance to complete the task. Of course, building sites can be identical in their physical construction, but they are never built on the same spot, and are rarely built at the same time or by the same people. Development and innovation within the building sector quite simply have a different significance than in more permanent enterprises.

In order for the workplace to function well, good knowledge of production, organization and leadership is necessary, both in those deciding on the parameters for the building work and in those employees who have to adjust to that framework in the workplace. A characteristic of the trade of today is that questions of production and work organization are often given low priority, and more and more decisions are left to the people carrying out the work. Complex planning questions are handled as if they were simple questions of preparation. Many questions are quite simply dealt with at the wrong level, and without collaboration, which easily leads to sub-optimization. In many cases it creates a poor working environment for everyone on the building site, and often causes unreasonably heavy workloads for site managers and foremen who are constantly having to deal with urgent problems [1] [2] [3]. Similar problems have been focussed upon by Ballard [4] and Koskela/Ballard [5].

Due to these increasing work environmental problems the building industry (building companies and trade unions together) in Sweden decided to launch the national development program "Korta byggtider" (Short time building schedules) in the beginning of 1990 [1] [2] [3]. The main factor for the studies in the program was the short time-schedules, which caused the problems of stress and the poor working environment and showed poor production planning.

In 1992 the program was reported on in the book "Bygga inför 2000-talet" (Building at the prospect of the 21st century) [3]. Many of the results presented in the book are still valid since many of the problems still remain in the building industry. The project

"Production planning, work organization and leadership on the building site" [18] is mainly a continuation and a following up study of the program "Korta byggtider".

The results presented in this paper are mainly based on the report from that project named *Building for the 21st century* [6] and the paper *Production planning, work organization and leadership on the building site* [18].

Here the conclusions of the project are presented with reference to the following aspects; production planning, work organization and leadership [6] [18].

The time schedule is the main instrument for production planning and control. However, there are some examples of the working environment plan as the dominant instrument for planning. Short time schedules are a very significant problem in the production planning process. The layout plan of the building site plays a minor role as a planning instrument in comparison with the manufacturing industry where the layout is of great importance.

Most building sites have some kind of model for cooperative planning, involving the building workers and craftsmen in the process. The level of the working environment planning varies greatly from site to site, due to the varying interest and knowledge of the site managers. In some cases it is regarded as the most important planning instrument and in other cases it is seen as a set of routines that have to be followed because of rules and regulations. The coordination of craftsmen from different firms and professions is very often left up to the craftsmen themselves. Personal and professional development of building workers and craftsmen is of low priority.

The view of good leadership among the actors on the building sites is mainly connected to factors such as social competence, detailed technical and functional knowledge but is very seldom related to the quality of the result and the production process. The theoretical knowledge of, and training in, leadership is very poor.

Site managers are to a high degree recruited among building workers with long experience. Managers with civil engineering and other university building engineering degrees tend to regard site management as a step on their career ladder and they do not want to stay at the building site longer than necessary.

Sustainable Wooden House Production

Wood as a building material is now experiencing a renaissance as part of the endeavour to find sustainable building materials. In the north of Sweden wood manufacturing is one of the most important industries with a great impact on the regional development. In the region there is a well-developed tradition in wooden house building so there is a good potential regarding raw materials as well as skill. The most appropriate fields for development are building multi-storey apartments in wood and in combinations of wood and other building materials.

The term "sustainable building" is used here to describe building processes that do not have a negative imact on the outdoor environment, indoor environment and work environment. *Sustainable wooden house production* [17] is a concept of building or rebuilding wooden houses in a sustainable way.

A large amount of the Swedish production of wood from sawmills is used within the building sector. The use of wood products in the building industry is thus of great importance for the forestry industry. During the last century wood has lost market share to other materials. Increased potential for the use of wood products in the building industry has emerged due to changed rules in the building laws for multi-storey buildings in wood and due to the environmental advantages.

It is important that wood is used in the correct way throughout the building process from the early production stage to the maintenance of the buildings. If not it might cause sick buildings and a poor indoor environment. There is evidence that the indoor environment is a determining factor for sick building syndrome (SBS). In order to save energy there is a need for more insulation and buildings are more tightly sealed, which leads to a need for increased ventilation to avoid poor air quality. In Sweden most buildings have mechanical ventilation while a combination of natural and mechanical ventilation is used in other countries. There are few investigations measuring how these two ventilation systems fulfil the various demands and recommendations.

Healthy buildings in this context means buildings that do not have a negative impact on the outdoor or the indoor environments, or on the working environment, while at the same time being of good quality, aesthetically appealing and financially worthwhile.

Wood as a natural material has a good potential for providing a basis for healthy buildings. It is however, very important that it is treated in a correct manner. If used incorrectly, wood can also give rise to a poor indoor environment. This applies to all stages of the building process, from production through to operation and maintenance.

The building technology of great interest in the Mid Sweden region is the development of building wooden houses. In the region there is a tradition of building houses from wood and thus there is potential for development in terms of the availability of the necessary raw materials and skills. Buildings that are particularly suitable for development are those with a major proportion of the materials consisting of wood, multi-storey buildings of wood and wood in combination with other materials.

The education of building engineers at Mid Sweden University has paved the way for expanding the research area through contacts with companies, organisations, public authorities and various networks. The research project entitled "Brukarnas kvalitets- och miljökrav i byggprocessen- en fallstudie av Campus Östersund" [translated as *"The users' requirements in the building process regarding environmental and quality demands - a case study on the Östersund Campus."]* [8] [9] was started in the spring of 1998. The purpose was to study obstacles to, and opportunities for, future users to influence their prospective working environment. Research student Ingrid Svetoft was actively monitoring the process under the supervision of Professor Jan Söderberg at the Department for Building Economics at LTH. The project linked to a certain extent to earlier projects concerning employee contribution conducted by Mikaelsson (1989 and 1992) [2] [3] and Söderberg (1989) [1]. The users' environmental and quality specifications mean that the total environment is taken into consideration. This includes the outdoor environment, the indoor environment and the working environment.

Increased use of wood as a building material in houses binds carbon and nitrogen for a long period of time, which makes a contribution to a better global environment. Wood is a renewable natural resource. In regions where there are many forests an increased use of wood in the building industry and an increased local refinement of the raw product will diminish transport requirements as well as reducing the need for other less sustainable materials. Wood has also been shown to have positive effects on the indoor environment. The results from the case studies show that it also improves the working environment for building workers.

An overall aim in the projects was to support development in regional trade and industry, and other organisations in the field. The building and wood industry have been very involved and the projects have also involved contacts with building engineering students through project works as well as knowledge transfer through conferences and seminars about wood building. One result from the projects is a deeper understanding of education, research and development in enterprises and other organisations.

The cooperation between enterprises, regional authorities and Mid Sweden University in the field of sustainable house production has deepened through the projects. One example is Mid Sweden University's involvement in the project *Production planning, work organisation and leadership at wooden house building project* (Mikaelsson, 2005) [12]. The results from that project show that the working environment is improved compared to ordinary concrete building, but there is a lot of development needed to optimize the logistics between the wood manufacturing company and the building enterprise on the building site.

Connections between the research project and the Building Engineer program has led to extensive development in the program. The education program and research projects have been strongly linked together, and the idea is that results can rapidly be disseminated through the program at the same time as the quality of the education is improved.

With net-based distance courses new target groups are reached, for example adult students and working professional engineers who need continuing education. The experiences from the net-based course on indoor environment have been adopted by the project *Flexible Engineering Education* to other courses and all courses in the building engineering program are now available on a WebCT platform [14] [15] [16]. In the longer term there are plans to reach international target groups by developing English language versions of the program.

The conditions for applied research and development are greatly improved as an effect of the projects. The ecobuilding field station in Ås, outside Östersund, started in 1995 as a cooperative project between the building engineering program at Mid Sweden University and the regional building industry can become a real centre for developing full-scale building projects for sustainable building. The idea is that the centre should work with cooperative projects between education, research and developers to create building products and systems.

Elements of an education for building workers are already established at the field station. There is now a factory for the construction of full-scale prototype timber houses. This is planned to be a joint venture between Mid Sweden University and the organisation JiLU, which was originally an agricultural/forestry School but now deals with rural development projects.

The role of Mid Sweden University is to build up an organisation for applied research in sustainable wooden house building, connected to the field station.

Case studies of the conversion of the former premises of the military regiment A4 into a modern and creative study environment at Campus Östersund charted some of the problems that can arise when users formulate specifications and wishes. This is complemented with laboratory trials and studies of other building objects. The project is well documented and a number of good examples from the projects can be used.

The case studies were investigated with the same action research methods that were used in the worker participation projects in Lund and Sundsvall (Mikaelsson, 1989 and 1992) [2] [3].

Parts of the research project have been conducted as case studies of the following building projects:

- A storage building at Campus Östersund which is to be converted into a student activity centre
- A model timber house factory built by JiLU in Ås with links to Torsta and the Mid Sweden University's eco-building field station.
- A multi-storey apartment building in solid wood
- Network collaboration with manufacturers of wooden buildings

The storage building and other smaller case studies were carried out as student projects. The focus was on applying the latest research results within the area of healthy wooden buildings to create good examples for future construction using wood as the principal building material.

A development of full-scale building at the field station at Ås is planned in connection to the model house factory. The plans include the building of rooms for research on indoor environments. The actual building of the model house factory is in itself a research project with the purpose of creating good examples of healthy wooden buildings.

Buildings that have experienced problems with indoor environment were also studied [7] [11]. As a consequence of collaboration with other universities we had access to the latest research on the indoor environment. Our contribution in this regard will be to analyse their research results in relation to the effects on the building process and the choice of materials. Special attention is focused on finding the extent to which major components of wood as building material can contribute to healthier environments.

Since there is a lot to be learned from traditional building in the context of timber construction, a special investigation was conducted with the objective of examining how traditional building with wood can be employed in the process in the areas of construction, production and user specifications [13].

Since the project is planned to continue it is not possible to present any final results. However some indications and preliminary conclusions can be drawn from the results so far. The first is that the construction of wooden houses will not develop rapidly. There is still considerable hesitation on the part of the commissioners of building projects, and building companies. The strongest actors in the process seem to be timber building manufacturers and the market. If a strong demand for healthy buildings develops there is a good chance that the market for wooden houses will increase. But there is also a great need for technical development and full scale experimental building in order to make wooden houses a real alternative to conventional buildings of concrete, steel and brick.

In short the results from the projects so far indicates the following conclusions:
- Optimization of wooden constructions contributes to the natural resources economy.
- Wooden houses are comparatively healthy using the formulated criteria.

- The rate of wooden house building is slowly rising in spite of the limited interest from the building industry.
- The wood building process requires increasing cooperation between building companies and wood house manufactures in order to improve the logistics with optimized solutions between site and factory constructions. There is a great potential for improvements in this field.
- The results from the study of the wooden house building project indicates that it provides equivalent or better conditions than ordinary building projects when it comes to production planning, work organisation and leadership.
- The wood building concept has a positive impact on the working environment on the building site especially concerning climate, noise and physical working conditions.
- Wooden house building could be the catalyst for the industrialization of the building process, with improvements in the working environment, more effective production planning, work organisation and leadership.

Flexible Engineering Education

The need for continuation courses for engineers already working in the profession is steadily increasing as new spheres of activity and problem areas arise within the field of engineering. Such courses are often delivered as commissioned courses or as single-subject courses. Since working adults have totally different study requirements compared to young students, such recurring courses must be carried out so that it is possible to combine studies with work and family life. In most cases this means part-time studies and some form of distance-education.

It is clearly an advantage if such courses can be combined with regular campus-based courses and that they are an integrated part of a program, making it possible for the student to receive accreditation. This will enable students to continue their education, leading to a higher degree level, for example, from engineer to graduate engineer or from Bachelor's degree to Master's degree. The Flexible Engineering Education [15] is a method of realizing these ambitions. Accordingly, it is about developing flexible courses and adapting the curricula so that they form part of a complete program, enabling professionally active engineers to continually raise the level of their formal education.

A course in indoor environment has been offered for the past few years by Mid Sweden University [14]. The course was developed in co-operation with Professor Jan Sundell at the Technical University of Denmark (DTU). The course is an attempt to establish a comprehensive view of the indoor environment and its importance for allergies, infections of the respiratory passages and other symptoms that can be linked to buildings and the indoor environment. Choice of building materials, building technology, installation technology and construction methods are discussed, as are energy consumption, cleaning and other aspects of the buildings' management and maintenance and the influence they have on the indoor environment and the working environment.

Allergies and other hypersensitivities are common symptoms and difficulties that can be linked to the indoor environment. The causes can be poor ventilation, emissions from materials, damp, mould etc. Despite the fact that these problems are well known, we have not succeeded in eliminating them from new buildings, or preventing their return in buildings where measures have already been taken.

Before beginning the project ”Flexible Engineering Education” [15] a survey was carried out among companies within the building and the real-estate sector. This survey showed that there was a great amount of interest in distance courses in indoor environment. Indoor environment was therefore judged to be a suitable course to develop as a prototype course for the project. By way of the Swedish Knowledge Foundation's (KK-Stiftelse) national project LLL (Life Long Learning), Mid Sweden University was granted funds to develop the course as a flexible distance course, in co-operation with three other universities [16].

It is worth mentioning that Mid Sweden University has extensive experience of distance education and since 2002 has had a special support function called ”Forum for Flexible Learning”. The forum supports the university’s departments in their work of developing and adapting courses for distance delivery.

Thanks to the extensive contact and discussions with prospective students during developmental work, a good foundation has been laid for quality assurance. The teachers who developed the original campus-based course have been deeply involved in developing the new, flexible course, which also guarantees high quality course content. The participant-controlled testing of the course has further improved quality.

The following factors have been especially important in course development work:
- Close contact with companies and other potential “consumers” during course development.
- Access to highly qualified competency within the subject area.
- Qualified technical support within Mid Sweden University
- Combination with research projects

All courses within the department are gradually being adapted according to the model presented above. So far the project has been limited to the building engineering program. In the future, further development work with flexible engineering education will be carried out in cooperation with the departments concerned and will involve all engineering courses.

Thus far, the results of the project demonstrate that combining campus-based courses with distance courses functions well using the course management software WebCT. However, there are many points to be taken into consideration when designing courses in this manner. As was mentioned in the course development section, the course must be adapted for distance education, for example by making all course materials available via the Internet and by creating learning activities to be carried out by the students individually or as part of a group. Campus students, however, still expect to meet their tutors/teachers on a regular basis, despite the fact that all course materials are available on the Web. These meetings must contain meaningful activities for both the students and the tutors. Such meetings may contain, for example, math workshops, in-depth studies of difficult topics, presentation of group assignments, revision and of course the opportunity to ask questions. To routinely deliver course materials that can be accessed on the web by means of lectures cannot be meaningful for either the student or the lecturer.

Further development work is needed to merge program students with those who are studying single-subject courses with the aim of gaining a degree in engineering, particularly concerning admission requirements and the order in which the courses must be studied. A foundation for this development work has already been laid in the earlier work with the engineering courses. An outline will be presented together with the final report, showing how the diploma of higher education in engineering can be achieved via program studies and via single-subject courses, and how these two paths can be combined by means of joint studies of compulsory and elective courses.

Guidelines for future work can be summarized as follows:
- More focus on learning – and less on teaching.
- Commitment to the entire program.
- Cultivation of experience, dissemination of good examples.
- Commitment to international course development projects.

Conclusions

The PAL project, which studied production planning, work organization and leadership in building sites, shows that the time schedule is the main instrument for production planning and control. However, there are some examples of the working environment plan as the dominant instrument for planning. Short time schedules are still a very significant problem in the production planning process.

Most building sites have some kind of model for cooperative planning involving building workers and craftsmen in the process. But the theoretical knowledge of, and training in, leadership is very poor. Site managers are to a high degree recruited among building workers with long experience.

In short the results from the study "Sustainable wooden house production" indicates that wooden houses are comparably healthy using the formulated criteria. The wood building process requires increasing cooperation between building companies and wood house manufacturers in order to improve the logistics with optimized solutions between site and factory constructions. There is great potential for improvements in this field. The wood building concept has a positive impact on the work environment on the building site especially concerning climate, noise and physiological work conditions. Wooden house building could be the catalyst for the industrialization of the building process, with improvements in the working environment, more effective production planning, work organisation and leadership.

The results of the project "Flexible Engineering Education" shows that combining campus-based courses with distance-course platforms such as WebCT is a way of improving the sustainable building engineering program and of reaching new target groups for the learning process. There are still many points to be taken into consideration when designing courses in this manner.

For future development work more focus must be placed on learning and less on teaching. Sustainable building is a way of thinking that has to be integrated in the entire education program. It should be based on both theoretical and practical experience, and on the dissemination of good examples.

The results from these development projects are gradually being implemented in the building engineering program at Mid Sweden University.

References

[1] Söderberg J/Schröder C/Korhonen M/Mikaelsson L-Å/Persson M/ Swensson L-G, 1989. *Integrerad planering. Försök med arbetstagarmedverkan vid planering av byggprojekt.* TEM/ Avdelningen för Byggnadsekonomi Tekniska Högskolan i Lund – Lunds Universitet, Lund

[2] Mikaelsson Lars-Åke, 1989. *Byggnadsarbetares involvering i planeringen av byggprojekt.* Rapport 1989:2 Högskolan i Sundsvall/ Härnösand. Avd. f. arbetsmiljöteknik LNTH, Lund (Doktorsavhandling).

[3] Mikaelsson L-Å/Bengtsson S/Lindell J/Larsson P, 1992. *Bygga inför 2000-talet (Building at the prospect of the 21st century),* Byggförlaget, Stockholm.

[4] Ballard Glenn, 2000, *The Last Planner System of Production Control.* School of Civil Engineering, Faculty of Engineering, The University of Birmingham.

[5] Koskela L/ Ballard G, 2006, *What is Lean Construction – 2006,* Joint 2006 CIB W065/ W055/W086 Symposium Proceedings

[6] Mikaelsson L-Å /Swensson L-G, 2006, *Bygga för 2000 – talet (Building for the 21st century),* Report from the project Produktionsplanering arbetsorganisation och ledarskap på byggarbetsplatsen (Production Planning, Work Organization and Leadership on the Building Site), Draft version and educational material and [6a-d] appendix 1-4 1.Literature Study, 2.Interviews, 3.Inquiry and 4.Quality in Building Production and Work Environment, Mid Sweden University/LTH Lund University.

[7] Sundell J, (1994), *On the association between building ventilation characterististics, some indoor environmental exposures, some allergic manifestations and subjective symptom reports,* Indoor air, Supplement 2, 1-148

[8] Svetoft, Ingrid, (2003), *The users' requirements in the building process regarding environmental and quality demands - a case study on the Östersund Campus,* Paper presented at Third Nordic Conference – Construction Economics and Organisation Lund Institute of Technology, Lund University, 23-24/4 –03

[9] Svetoft, Ingrid (2005), *Brukarnas krav i byggprocessen - en fallstudie*; Licentiate treatise. Institutionen för byggvetenskaper, LTH, Lunds universitet, 2005.

[10] Mikaelsson, L-Å. (2003), *Healthy Wooden Houses*, Paper presented at Third Nordic Conference – Construction Economics and Organisation Lund Institute of Technology, Lund University, 23-24/4 –03

[11] Bångman, Gunnel (2004), *A Valuation of Good Indoor Air Quality in Swedish Dwellings/Motives for Valuing Good Indoor Air Quality – Altruism or Egoism,* Articles presented in dissertation (2006)

[12] Mikaelsson, Lars-Åke (2005), *Produktionsplanering, arbetsorganisation och ledarskap vid trähusbyggnadsprojekt;* Projektrapport 2005-12-31 Mittuniversitetet

[13] Jämtsäter, Marianne (2004), *Synen på trä och träbyggande - Processer i samhället som styrt och drivit synen på trä som byggnadsmaterial*; Delrapport Sunda trähus

[14] Mikaelsson, Lars-Åke. Nykvist, Bengt (2003), *Utveckling av distansutbildning i inomhusmiljö 5p*. Slutrapport LLL

[15] Mikaelsson, L-Å. Nykvist, B. (2004), *Flexible Engineering Education.* Paper presented at IACEE Tokyo May –04

[16] Mikaelsson, L-Å. Nykvist, B. Pålsson, J. (2004), *Transforming a campus based course to a net based – Practical experiences in continuing engineering education*; Paper presented at EDEN Budapest June –04

[17] Mikaelsson L-Å (2006), *Sustainable Wooden House Production.* CIB, Rome 2006

[18] Mikaelsson L-Å /Swensson L-G (2008), *Production Planning, Work Organization and Leadership on the Building Site.* CIB, Helsinki 2008

Mapping sustainability assessment in relation to the life-cycle of a university campus project

Dr Craig Thomson[1], Dr Mohamed El-Haram[2], Dr Rohinton Emmanuel[1]

1 – Glasgow Caledonian University, UK

2 – University of Dundee, UK

Sustainability assessment is increasingly recognised as playing a wider role than purely a technically based exercise that is focused on assessing the sustainability performance of building projects. The potential has been suggested for sustainability assessment to evolve as a tool that facilitates the consideration and management of sustainability across the different stages of the project lifecycle. This aligns with calls for assessment to increasingly contribute to the predominantly subjective approach to decision making within the built environment and the need to increase the level of integration between the activities of assessment and the project lifecycle. Key to such an approach, sustainability assessment offers a role in aiding stakeholder engagement and mediation, in addition to providing a stimulus for the required learning amongst practitioners to aid the delivery of project sustainability. However, the realisation of this aspiration has so far been limited in practice with many pointing to the lack of understanding amongst practitioners of the concept of sustainability, the nature of the assessment tools and the implications these present to current practice.

This paper aims to contribute towards this emerging understanding by considering an empirically based case study which follows the application of sustainability assessment across the lifecycle of an active project. A grounded theory approach was adopted, and a series of interviews conducted with those who were involved or influenced by the consideration of sustainability and its assessment across the lifecycle of the project. Presented are the findings of an exercise aimed at identifying the emerging phases and activities of sustainability assessment that were found in practice. The case study represented a progressive attempt by a project team to consider sustainability and to use assessment to guide the development of a university campus building project within the UK. The paper explores the application of sustainability assessment in relation to the key phases of the process i.e. identification of project sustainability issues, selection of an appropriate sustainability assessment tools, the implementation of the assessment tool and during the consideration of its outputs; and across the stages of the project lifecycle By exploring an empirical context that is forward thinking by nature, some key lessons are drawn to facilitate the evolution of sustainability assessment towards the advocated approach in practice.

Keywords: assessment tools, built environment, life-cycle, projects, sustainability assessment

1 Introduction

Increasingly sustainability assessment is perceived as a necessary tool for understanding the social, economic and environmental consequences associated with the way we design, build, operate, maintain and ultimately dispose of buildings and their support systems (El-Haram et al. 2007). However, the lack of a common framework and language around which to consider and assess sustainability, in addition to the absence of a truly integrated assessment tool, has resulted in the lack of a useable approach for practitioners to aid in its delivery within current building projects (Deakin et al. 2002; Brandon et al. 1997). Despite this, many argue that sustainability assessment has a key role to play in creating an environment where stakeholders are forced to rethink their priorities through the examination of the potential impact of their project on sustainability (Pope et al. 2004; Cole 2005). Assessment is called on to provide tangible information on key aspects of urban sustainability, providing guidance during the decision-making process in a manner that is transparent to and inclusive of the stakeholders involved (Mathur et al. 2008; Thomson et al. 2009). In viewing it as a proactive tool for instilling sustainability into decision-making, the likes of Lutzkendorf and Lorenz (2006) argue that through the promotion of discourse between stakeholders around the principles and implications of sustainability, a shared understanding can be fostered and applied to the contextual requirements of the building project. Kaatz et al. (2006) argues that an increased appreciation gained through assessment of the priorities of others, plays a significant role in aiding the mediation and inclusion of their values during decision-making within the project environment. In establishing such an environment during assessment, the basis is provided for an increased understanding of both the concept and its implications through the sharing and transfer of knowledge between practitioners and other stakeholders (Thomson et al. 2008). Significantly, the potential exists for this acquired knowledge and experience to be applied in future development projects with the objective of encouraging and promoting the sustainability during decision making.

The realisation of this aspiration has so far been limited in practice with many pointing to the lack of understanding amongst practitioners of the concept of sustainability, the nature of the assessment tools and the implications that these present to current practice as restricting the opportunity for evolution. It is argued that predominantly assessment tools are applied in a reactive manner, focusing simply on understanding and quantifying the flow of resources intended to be used within the project (Thomson et al. 2009). Recent awareness has emerged that such an approach is inadequate to support the predominantly subjective nature of the decision-making processes surrounding sustainability in the built environment (Lee 2006). If a more proactive approach is to be fostered, a better understanding is required of the role that assessment plays in delivering sustainability across the different lifecycle stages of the development project (Kaatz et al. 2006). Walton et al. (2005) in a review of 675 assessment tools identified significant variation in the nature of their applicability and function, and in the profile of the stakeholders involved over the course of the project lifecycle. However, despite the apparent volume and variation in the types of tools available (Fowler and Rauch 2006; Cole 2005; Deakin et al. 2002; Mitchell et al. 1995), practitioners commonly display a lack of awareness of other tools outside of the nationally based checklists such as BREEAM (BREEAM 2007), LEED (LEED 2008) and other tools such as SB tool (SB tool 2007), with evidence suggesting that often these tools are commonly applied in a reactive manner as opposed to the proactive manner intended.

This paper aims to contribute towards an emerging understanding of how sustainability assessment is applied in practice by considering an empirically based case study and to follow the assessment during its different phases across the project lifecycle. The case study illustrates a progressive attempt by the team to consider sustainability and to use assessment to guide its design, construction and operation. In order to understand the integration between the management of the project and the sustainability assessment, the phases and key activities of the assessment are identified and mapped in relation to stages of the project lifecycle. Knowledge mapping was adopted to identify the key-decision makers and various stakeholders involved, defining their roles, establishing where the knowledge resides and the nature of its flow during the phases of assessment and in relation to the stage of the project lifecycle. By considering a project that adopted a progressive approach to sustainability, some key lessons can be drawn to aid the evolution of sustainability assessment in practice towards the approach advocated.

2 Case study project background

The project emerged as a response to the need for a building to house a new Medical Sciences Institute at a UK university, to provide enlarged dedicated areas for medical research, biology teaching, chemistry teaching and photonics research. With planning permission obtained, preliminary works started in June 2008 with construction activities commencing at the start of July 2008 and a completion date targeted for January 2010. As an institution, sustainability was clearly rooted within the University's governance processes and practices, and was captured within the institutions sustainability policy and outlined in the sustainability strategy. As a project, a diverse range of stakeholders exist displaying a variation in interests and requirements from the building whether it be members of the project team, building users (academics, researchers, students, facilities managers), local and business communities influenced by its construction and its operation. The consideration of their needs has been aided to a large extent within the project as it was driven by the estates department of the University. The estates department displayed a vested interest in the construction phase achieving a focus on minimising the level of disturbance caused and in maintaining the operational performance and efficiency of the completed building forming a significant driver in the design and procurement decisions taken. The client actively sought a project team that would work with them to deliver a sustainable build, by appointing team members who they had either worked with before or could demonstrate sustainability credentials. The project was procured using a two stage procurement strategy.

The client had applied BREEAM (Building Research Establishment Environmental Assessment Method) (BREEAM 2007) as a tool for sustainability assessment within previous campus projects, but felt initially that the criteria offered failed to reflect the sustainability requirements of this building. The appointment of a sustainability advisor based with BRE (Building Research Establishment) provided the team with the knowledge to reach an agreement to adopt a tool that is based on the development of BESPOKE assessment criteria that reflected the nature of the building and its specific requirements. As an institution, the University is currently working towards a target of reducing its carbon dioxide emissions by 31,000 tonnes by 2012. This equates to a saving of £500K based on forecast 2012 energy prices. The Carbon Trust advises the University through their Carbon Management Programme to develop a targeted framework to deliver these targets, and as a result became involved in the project. They developed additional criteria for assessment that supplemented those of the core BREEAM assessment and additional BESPOKE criteria. The project initially set out to achieve a 'Very Good' BREEAM rating, but it has been identified that the potential exists to achieve an 'Excellent' rating and the team members are actively pursuing this.

3 Methodology

An empirically based case study was identified as an effective means of examining the experience and interaction of those participating in sustainability assessment within the project (Yin 2003). By focusing on a real life example of assessment applied in practice, an opportunity is provided to gain greater understanding of the nature of its application across the different stages of the project lifecycle, in addition to its knowledge requirements and the nature of its flow. A series of semi-structured interviews, were conducted with those members of the project team involved or influenced by the application of the sustainability assessment within the project. The interviews were split in two phases, the first to develop an understanding of the project, the approach to sustainability, and the different phases of sustainability assessment across the project lifecycle. As a result, an interview was conducted with an individual who could provide an overview of the project and its consideration of sustainability, from its inception and across the various stages of the lifecycle. In this case the University's Environment and Energy Manager provided the required overview and understanding. The second phase aimed to focus in detail on those who participated specifically in the sustainability assessment in order to gain a practitioner's insight into the associated knowledge requirements, who is involved, what knowledge is required, who holds the knowledge, the nature of its flow and what mechanisms can be provided to aid its flow during a sustainability assessment. The interviews conducted during this phase were with the sustainability advisor, assessor and projects architect.

Knowledge mapping is a technique that has been adopted commonly by multi-nationals to understand where knowledge resides in their organisations, and the nature of its transfer between those who hold it (Vestal 2005). When applied in this context, knowledge mapping provides the basis for understanding the requirements associated with the individual stages of sustainability assessment. During the analysis, techniques such as organisational network analysis (ONA) (Vestal 2005) were deployed under the principles of grounded theory (Straus and Corbin 1990) in order that the nature of the relationship between the stakeholders is understood, identifying who is involved during an assessment, define what their role is, what knowledge they hold, what knowledge they require, and its preferred method of transfer. Grounded theory ensured that the findings were emergent by nature, rooted in the context and experience encountered within the case study.

It was observed that different professions representing the planning, design, construction, and operation stages of a development project understand the stages of the project lifecycle in a slightly different manner. A review was conducted to identify a suitable interpretation of the project lifecycle around which the various professions involved could relate the activities of their role with those required for achieving sustainability. These included RIBA plan of works (1999 2007), Process Protocol (Aouad et al. 1998), Building Design Management (Gray and Hughes 2001), The Office of Government Commerce Gateway Project Process (OGC 2007) and the HOK integrated design process (Mendler et al. 2005); with the RIBA plan of works 2007 identified as the most effective structure due to its wide recognition (Thomson et al. 2008). This provided the common structure around which this case study and particularly the mapping can be considered.

4 Mapping sustainability assessment

Four key phases of sustainability assessment were identified within the research around which the key-decisions are taken i.e. identification of project sustainability issues, selection of sustainability assessment tools, implementation of the assessment, and consideration of tool outputs. The case study provided the opportunity to understand the role of the various stakeholders during each of these phases, and to map these different phases and the nature of stakeholder involvement across the project lifecycle. These maps provide an illustration of how sustainability assessment is a consideration through the stages of the project lifecycle, and provides the basis for the management of sustainability within the project. To enhance the level of understanding, a representation of the sustainability issues is provided as they emerge across the project lifecycle. The findings within this section emerged exclusively from the interviews conducted representing those involved or in delivering those phases of assessment.

4.1 Stakeholder involvement in project sustainability assessment

The analysis represented an initial mapping exercise to understand who was involved during each phase of the sustainability assessment. A list was established during the interviews of those involved and this was followed by a wider mapping exercise to identify at which phase of the assessment that this involvement took place. A summary of the findings is presented in figure 1. The figure illustrates that across all the phases the project board, client representative and sustainability advisor were involved. The project board and the client representative were responsible for delivering sustainability within the project, and in order to aid its management through assessment, they drew on the expertise of a sustainability advisor. The other stakeholders identified as participating in the assessment process were observed to contribute during the individual phases in a manner that reflected their role and the nature of the phase. The figure outlines the nature of the involvement played by each stakeholder during each phase of assessment.

Emerging from the analysis were seven different roles played by the stakeholders through their involvement i.e. the key-decision maker, responsible for overseeing activity, responsible for conducting the assessment, advising, consulted, evidence provision, informed and not included. A hierarchy was detected that required to be reflected, with ultimate responsibility lying with the project board within the decision-making process. Whilst they were not involved in the detail of the assessment, they would still perform the role of key-decision maker. The client representative took on the role of overseeing each of the phases of assessment, with expert advice and support coming from the sustainability advisor throughout and from the Carbon Trust (with exception of tool selection). The assessment was conducted by the sustainability advisor and sustainability assessor, and the evidence provided by members of the design and construction teams, in addition to specialist consultants (e.g. ecologist). A distinction was noted between those who provided advice as an expert (i.e. sustainability advisor, Carbon Trust), those who were consulted for input by the team (architect, project management consultancy and building users), and those who were informed of its progress (e.g. building users).

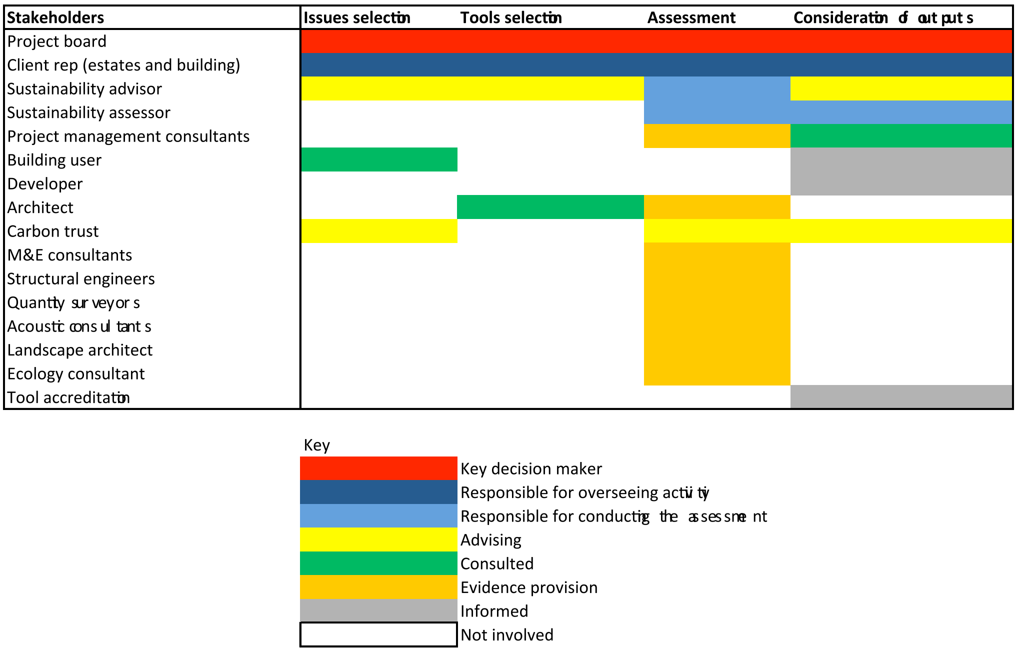


Figure 1: Project involvement in stages of assessment

During the selection of the sustainability issues, the project board and client representative demonstrated a good understanding of the issues that they wished to address within both the project and through an assessment. This was informed largely by the strong emphasis on sustainability running through the University's policies and strategies. The client representative stressed a focus on the operational considerations of the building, in addition to a need to minimise the impact of the construction phase on the campus as a whole. Initial issues of priority requiring consideration within this project were energy, cost, materials, water and biodiversity. Reflecting the emphasis on sustainability within the project, a sustainability advisor was employed as part of the team to provide expert advice regarding: the identification of suitable sustainability issues to address; the selection of an appropriate tool that meet the needs of the project; to advise the design and construction team during the development of the project; and to aid the implementation of the assessment. The Carbon Trust provided advice during the process of issues selection, although this emerged slightly later in the project lifecycle and required the issues initially selected to be revisited in light of the carbon agenda. As part of the projects wider engagement process, the potential users of the building i.e. as the academic staff, researchers, administrative, servicing staff and student bodies; were consulted regarding the sustainability issues they wished to see reflected. Given the public nature of the building nature and the emphasis on sustainability by the university, formal consultation regarding the sustainability issues was not explicitly sought with wider stakeholders, as the client body felt their requirements were implicitly reflected.

The university displayed familiarity with sustainability assessment, and had implemented BREEAM assessments on previous campus projects. Concern existed that the criteria within BREEAM was inappropriate to reflect the specific nature of the building given its wide ranging functionality, and the sustainability aspirations of the university. The sustainability advisor worked closely with the client representative to convince the project board that a BREEAM assessment would be suitable, if it was supported by BESPOKE sustainability criteria that reflected the function of the building and the University's additional criteria.

During this process, the architect was consulted to ensure that the emerging preliminary design was reflective of these aspirations and that these criteria could be delivered in practice. The sustainability advisor developed BESPOKE criteria for assessment that reflected these considerations, in addition to the requirements introduced by the Carbon Trust.

Although the client representative was responsible to the project board for the delivery of the sustainability assessment, it was the sustainability advisor and assessor who managed the collation of the evidence required from the design and construction teams, preformed the assessments and produced the reports. The sustainability assessor had responsibility for managing the traditional BREEAM assessment with the sustainability advisor overseeing the assessment of the additional BESPOKE criteria. The final assessment was post design by nature, and throughout the design process both the advisor and assessor liaised with the design team to ensure that the emerging design fell in line with the agreed BREEAM rating. It was this constant feedback that enabled an awareness amongst the team that through some modifications the emerging design had the potential to achieve a higher rating from its initial 'Very Good' to an potential 'Excellent'. This process was supported by some initial workshops provided by the sustainability assessor to help the design team to understand the expectations and processes involved in assessment. In addition, the sustainability advisor kept the client representative and project board abreast of the progress being made throughout the design phase. This allowed the project board as key-decision maker to revise the targets, and encourage the design team to achieve the higher rating.

The intention is for the outputs of the assessments to be available as the project moves into the construction phase. This provides two main functions, firstly to communicate the sustainability issues and associated targets to the developer and future operators of the building, and secondly to act as a tool for dissemination within the project team. The assessments will display a technical report which is used to support the first function and a simple rating and certificate to support the later. The project board decide the approach to the dissemination of the rating to the wider public, however, it is the sustainability advisor and assessor who require to interpret the technical report to the client representative and project management consultant, in order that they can inform the developer and future user of the building of the implications for their practices. This is preformed through written documentation and supportive meetings.

4.2 Sustainability assessment across the project lifecycle

Given this understanding, a mapping exercise was conducted to explore the nature of these phases of assessment in relation to the project lifecycle and to chart the nature of stakeholder involvement in relation to this. Figure 2 illustrates three representations: an interpretation of the phases of assessment, the involvement of the stakeholders, and the nature of that involvement in relation to the stages of the RIBA Plan of Works 2007 (RIBA 2007).

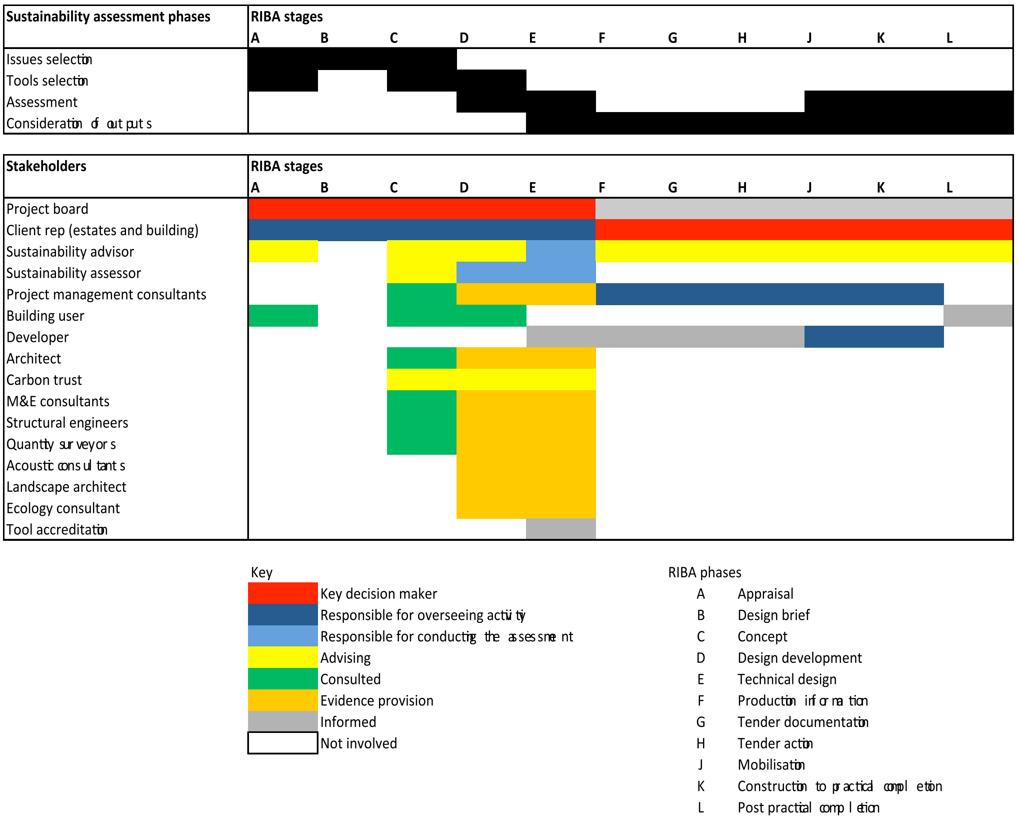


Figure 2: Project team involvement across RIBA stages in sustainability

Representing the phases of assessment across the project lifecycle highlights the often over lapping nature of these phases and the iterative manner which they are revisited during later stages of the project. This is illustrated in the process of selecting issues and the assessment tool. As a result of the University's experience of using BREEAM, they started with a good idea of the type of tool they were looking to adopt. During stage A, the client body expressed concern in the suitability of applying BREEAM and began a search for an alternative tool to match the initial set of sustainability issues identified. The figure illustrates the involvement of the project board, client representative and the role of the sustainability advisor in providing expert advice during this period. Consultation is also illustrated with those who will potentially use the building. Although the team were comfortable with the issues identified, the selection of the tool remained unresolved until stage C, when the sustainability advisor convinced the project board that a BREEAM assessment supported by a BESPOKE criteria based around the University's broader set of sustainability issues, could be delivered. At this point, the Carbon Trust became involved in the discussions and offered to fund a carbon emissions assessment in tandem with the BESPOKE assessment. As a result, the team revisited the selected issues and updated the criteria around which the BESPOKE assessment was structured. A sustainability assessor was employed at this point to advise the team on the implications of the different BREEAM ratings, and to contribute to the discussions between the client representative, sustainability advisor and the project board during the process of setting the target rating (i.e. 'Very Good'). Members of the design team were consulted to ensure the achievability of the rating and to ensure that the expectations for the emerging design were understood.

The implementation of the assessment tools took place over the course of stages C, D, and E with the final assessment being delivered and submitted to the BRE for accreditation at the end of the design stages. The advisor and assessor worked closely with the design team to ensure that they understood the evidence requirements and to provide a monitoring function to consider the implications of the merging design against the desired rating. In considering the tool in this manner, the criteria and identified ratings were used to guide the evolution of the design and as a planning aid to procurement and construction activities. Evidence was gathered from members of the design team and a range of consultants brought in to support the assessments i.e. the ecological consultant. The submission of evidence was managed for the BREEAM criteria through the assessor, with the additional criteria for the BESPOKE assessment managed by the advisor. Increasingly, BREEAM assessments are required to be performed post-construction following 6 months occupation, but in this case it was conducted post-design with careful monitoring of its performance in construction and operation planned to support this. Due to the nature of the procurement route the developer was not involved in the assessment until stage E.

The intention was for the assessment outputs to provide the benchmark against which the post-design activities are considered. This ensures that decisions taken for the construction activities and the procurement of suppliers conform to the requirements of the assessment. During this phase, responsibility falls to the project management consultant to work with the sustainability advisor and the client representative to ensure that this is delivered in practice with the developer. Regular feedback was provided to the project board, to allow for changes to be made if required. During the construction and operational phase of the project lifecycle it was clear that a degree of assessment is required to ensure that the sustainability performance of the practices on site, the emerging building and finally the operational building, all align with the criteria and rating established within the assessment. This was recognised as a necessary element, as the university wanted to learn from the experience of this project in order that continuous improvement can be provided in future projects. Throughout this process the client representative took on the responsibility of key-decision maker, as the estates department was ultimately responsible for managing the operational performance of the building.

4.3 Sustainability issues considered during lifecycle stages

Displayed in figure 3 are the sustainability issues that emerged during the project against the main RIBA Plan of Works stages, detailing in the first level those described by the project team as the priority considerations, the second level those assessed as part of the BESPOKE criteria, and the third outlines the BREEAM criteria assessed by the team. It is necessary to point out that the BREEAM criteria are not presented in any order or in relation to the stages of the RIBA Plan of Works.

The principle priorities outlined initially by the project board and client representative related to cost, energy, materials, water, land use and biodiversity. These represented a mix of the priorities of the estates and buildings department who were concerned with the operational performance of the building (i.e. energy, cost, water) and those additional priorities of the University's sustainability strategies and policies (land use and biodiversity). The project board and the client rep's whole life view of the project, aided in allowing sustainability issues to be built into the activities of design, construction and operation due to the recognised value to potentially improve operational performance, especially with regards to costs, energy and more attractive environment that contributes to the wider campus (biodiversity, water and land use). It is apparent that the sustainability issues of concern during the design phases reflect the means of achieving these higher level issues by setting principles around which the activities of design are set. During this stage it is possible to recognise a move towards a concern for carbon dioxide emissions, waste, and transport. This reflects the additional criteria of issues suggested by the sustainability advisor and the Carbon Trust. As the project moves beyond the design phase, concern shifted towards ensuring that the construction phases deliver sustainable materials, health and safety on site and minimise the impact of the project on the surrounding area. This is not surprising, and so the overall assessment moves towards a monitoring and auditing role. Reflecting the concern for the whole lifecycle of the project by the project board and client rep, it is not surprising to see the issues being considered during the use or operation of the building taking on the role of assessing the actual performance delivered by the building in practice.

The BREEAM criteria for assessment consider a wide range of sustainability issues, many of which match with the issues identified by the project board and it addresses these in a specific manner. It was the role of the sustainability advisor to consider the sustainability priorities of the project board and to identify those which were not addressed in the BREEAM criteria and to ensure that the BESPOKE criteria addressed these by highlighting and assessing their sustainability.

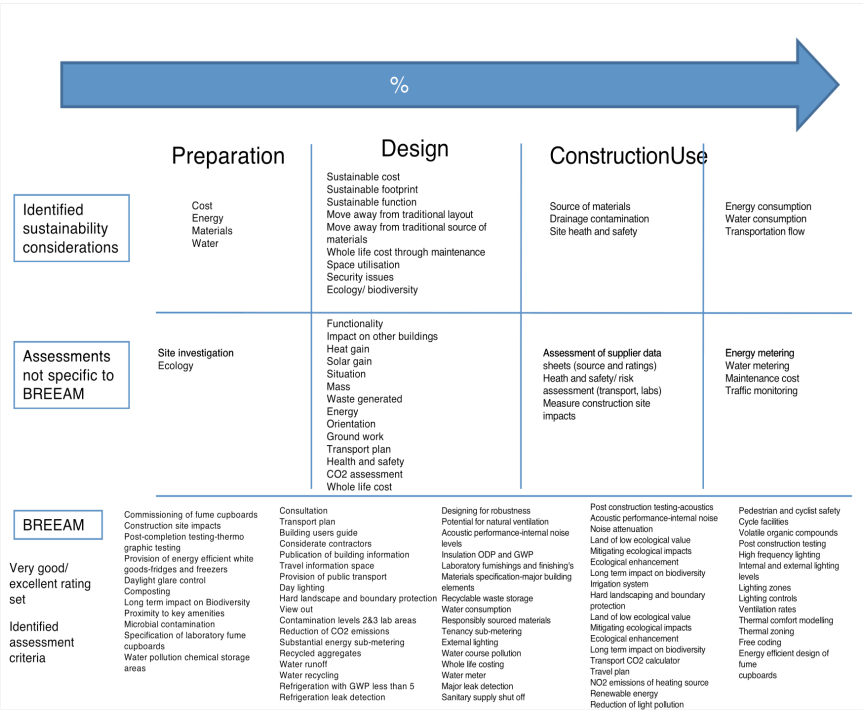


Figure 5: Sustainability considerations for assessment identified across the project lifecycle

5 Key findings

During the analysis six key factors emerged as important for sustainability assessment to be realised in practice in the advocated manner. The factors emerged from the analysis of the case study, with some successfully demonstrated in practice and others requiring further consideration.

5.1 The contribution of expert guidance

The research demonstrated the value gained throughout the process by the expert knowledge provided by the sustainability advisor. This role is not typical within a project team, but in this case the contribution was clearly beneficial in supporting the level of understanding of members of the team regarding both sustainability and its assessment during relevant decision points of the project. The client body recognised the potential value of this role from the inception of the project. The guiding role provided through the advisor's experience and general understanding, coupled with their technical expertise clearly improved the team's ability to engage with the sustainability agenda and to effectively interact with its assessment across the project lifecycle.

5.2 Realising actual performance through assessment

The assessment was conducted post-design, but it is increasingly recommended that a better picture of the buildings sustainability performance is gained by performing the assessment post-construction and after 6 months of operation. That way the rating achieved reflects the actual performance as opposed to simply a predicted one. This would place greater emphasis on the role of facilities management and its influence on sustainability. In addition, the behaviour of the buildings users would represented in the performance of the building.

5.3 Striving for aspirational practice

Although this project represents a progressive attempt to deliver sustainability with an 'Excellent' BREEAM rating being achieved, there were a couple of aspects that require future consideration. Whilst whole life costing was considered within this project, a greater emphasis was required for the wider issues of sustainability across the whole life cycle. BREEAM by its nature has a limited provision for socio-economic issues. The team tried to incorporate some of these additional issues through the BESPOKE criteria. However, it is widely acknowledged that even best practice examples (such as this project) fail to reflect the wider principles of sustainable development, as they represent a culture of mere compliance with legalisation that is acknowledged by many to be behind the curve. Within the UK building projects are emerging that view sustainability in its wider sense (i.e. development in line with environmental limits and quality of life), an aspiration around which decisions of design, construction and operation are based. Projects developed by Bioregional Quintain such as the BEDZED and Greater Middlehaven (Bioregional, 2008), are being developed in line with One Planet Living Principles (Desia and King 2006). Within these projects targets are set in line with OPL, and the likes of BREEAM are considered within a suite of assessment tools used to support the project's quest to deliver aspirational targets and therefore go far above legislative demands.

5.4 Implications of procurement route on the inclusion of wider project team

In selecting a two-stage procurement route the ability of the developer to be involved in any of the assessment phases was observed to be significantly restricted. Evidence from projects able to include the construction team in the selection of the project's sustainability issues, demonstrate not only the buy-in of the construction team around its objectives, but also benefit from the input of those considering sustainability from a site viewpoint, and thus aid project teams to set realistic targets that are deliverable in practice.

5.5 Significance of leadership

Leadership within the assessment process was demonstrated to be extremely important to the success of the assessment within this project. From the outset of the project the client body set a direction which placed sustainability as a clear priority within the project. They displayed a good understanding of sustainability and the role of assessment, and were well placed to provide the required leadership. This ensured involvement at all phases of the assessment process ensuring adequate feedback between the assessment and the decision points across the project lifecycle. The client body displayed significant leadership in their recognition that additional guidance from a sustainability advisor would be beneficial and through their commitment to sustainability by effectively resourcing the assessment.

5.6 Engagement as an aid for performance improvement

Through the engagement of the relevant stakeholders across the process, the team were able to contribute to the assessment across all of the phases, and therefore learn from each other and benefit from the expert advice provided by the sustainability advisor and assessor. The awareness created amongst the team of the evolution of the assessment process and its requirements aided in the collation of the evidence and presented the opportunity for the team to recognise the potential to improve the sustainability of the building.

6 Conclusions

Sustainability assessment plays an increasing role in the development of our urban environment, and a better understanding is required of the nature of its practical application within the project environment. In recognising that the evolution of sustainability assessment lies not solely as a purely technical exercise, but as a valuable process for the promotion of urban sustainability through stakeholder engagement, mediation and learning; new challenges are placed on the management of knowledge. This paper has considered an empirically based case study and followed the assessment during its different phases across the project lifecycle. The case study demonstrated a progressive attempt by a University to consider sustainability and the application of an assessment that intended to act as a guide to the design, construction and operation of the building. As a client, they illustrated a clear strategic appreciation of the value of sustainability, partly due to their role in managing its eventual operation and therefore emphasised a need to maximise the building's performance given their whole life responsibility for it; but also as part of their development strategy for the campus and the need to promote and ensure that this follows a sustainable direction.

In mapping the four stages of assessment across the project lifecycle and in identifying the role of the relevant stakeholders within this, a process was identified in this case that reflected the intertwined nature of the selection of sustainability issues and tools. This was partly due to the prior experience of the client body in using an assessment tool like BREEAM, but confirmed the often iterative nature of the decision making that surrounds these two phases of assessment. Highlighted was the value of developing an assessment methodology that accommodates the context of the project, in this case the requirements of the client and the specific function of the building demonstrated through the BESPOKE criteria. In applying the assessment in practice, the significance and value of a structured approach to managing the gathering and collation of data and evidence required was highlighted as enabling effective feedback between the assessment and decision making processes.

Stressed was the need to support decision making within each stage by facilitating the flow of knowledge regarding sustainability and its assessment as widely within the project team as appropriate. This allowed the team to demonstrate a high capacity for social learning about both sustainability as a concept and its assessment, and this was best demonstrated through the ability of the team to recognise the opportunity to raise the BREEAM rating during the design process.

7 Acknowledgements

This research would not have been possible without the willingness of the project team to contribute and spend time with the research team. The authors also gratefully acknowledge the financial support of the UK EPSRC (grant reference: EP/C008030/1) and the contribution of all the participating researchers from Dundee, Glasgow Caledonian, Loughborough and St. Andrews Universities who make up the SUE-MoT research consortium.

8 References

Aouad, G, Cooper, R, Kagioglou, M, Hinks, J and SEXTON M (1998) A synchronised process/ IT model to support the co-maturation of processes and IT in the construction sector. Proceedings of CIB Working Commission W78 – Information Technology in Construction Conference, Royal Institute of Technology – Stockholm, 85-95.

Bioregional (2008) Bioregional, website: http://www.bioregional.com/ (accessed 28 December 2008)

Brandon, P S, Lombardi, P L and Bentivegna, V (1997) "Evaluation of the built environment for sustainability", London: E & FN Spon.

BREEAM (2007) "Building Research Establishment Environmental Assessment Method", tool website: www.breeam.org (accessed 31 December 2008)

Cole, R (2005) Building environmental assessment methods: redefining intentions and roles, "Building Research & Information", volume 33, issue 5, 455-467.

Deakin, M, Huovila, P, Rao, S, Sunikka, M and Vreeker R (2002) The assessment of sustainable urban development, "Building Research & Information", volume 30, No 2, 95-108.

Desai, P and King, P (2006) "One Planet Living – A Guide to Enjoying Life on Our One Planet" ,Bristol, UK: Alastair Sawday Publishing

El-Haram, M. Walton, J S Horner R M W, Hardcastle, C, Price, A, Bebbington, J, Thomson, C S and Atkin-Wright, T (2007) Development of an integrated sustainability assessment: In Horner, R M W, Hardcastle, C, Price, A, Bebbington, J (Eds) Proceedings of the International Conference on Whole Life Urban Sustainability and its Assessment, Glasgow, June 2007.

Fowler, KM, Rauch, E M, (2006) "Sustainable Building Rating Systems Summary". Pacific Northwest National Laboratory https://www.usgbc.org/ShowFile.aspx?DocumentID=1915 (accessed 16 December 2008)

Gray, C and Hughes, W (2001) "Building Design Management", London: Elsevier.

Kaatz, E, Root, D S, Bowen, P A, and Hill, R (2006) Advancing key outcomes of sustainability building assessment, "Building Research & Information", volume 34, No 4, 308-320.

LEED (2008) "Leadership in Energy and Environmental Design", tool website: www.usgbc.org/LEED (accessed 31 December 2008)

Lee, N (2006) Bridging the gap between theory and practice in integrated assessment, "Environmental Impact Assessment Review", volume 26, issue 1, 57-78.

Lutzkendorf, T and Lorenz, D P (2006) Using an integrated performance approach in building assessment tools, "Building Research & Information", Volume 34, No 4, 334-356.

Mathur, V N, Price, A D F and Austin, S (2008) Conceptualizing stakeholder engagement in the context of sustainability and its assessment, "Construction Management and Economics", volume 26, issue 6, 601-609

Mendler, S F, Odell, W and Lazarus, M A (2005) "The HOK Guidebook to Sustainable Design", 2nd Edition, New Jersey US: John Whiley Inc.

Mitchell, G, May, A, and McDonald, A (1995) PICABUE: a methodological framework for the development of indicators of sustainable development, "International Journal of Sustainable Development World Ecology", Volume 2, No 2, 104-123.

Office of Government and Commerce, (2007) "Sustainability: achieving excellence in construction procurement guide", http://www.ogc.gov.uk/ppm_documents_construction.asp, (accessed 31 December 2008)

Pope, J, Annandale, D, Morrison-Saunders, A (2004) Conceptualising sustainability assessment, "Environmental Impact Assessment Review", volume 24, 595-616

RIBA (1999) "Outline plan of works, services supplement: design and management, in standard form of agreement for the appointment of an architect (SFA/99)", RIBA publications.

RIBA (2007) "Outline plan of works 2007", RIBA publications.

SBTool (2007) "Sustainable Building Tool", tool website: http://www.iisbe.org/iisbe/sbc2k8/sbc2k8-dwn.htm (accessed 31 December 2008)

Straus, A and Corbin, J (1990) "Grounded Theory in Practice", London: Sage publications Ltd.

Thomson, C S, El-Haram, M A, and Hardcastle, C (2009) Developing a KMS supportive of urban sustainability assessment, "Engineering Sustainability", ICE Journal, Thomas Telford, in press

Thomson, C S, El-Haram, M A, Hardcastle, C and Horner, R M W (2008) Developing an urban sustainability assessment protocol reflecting the project lifecycle. In: Dainty, A (Ed) Procs 24th Annual ARCOM Conference, 1-3 September 2008, Cardiff, UK, Association of Researchers in Construction Management, 1155-1164.

Vestal, W (2005) "Knowledge mapping- the essentials for success", Houston, US:APQC publications.

Walton, J S, El-Haram, M, Castillo, N H, Horner, R M W, Price, A D F and Hardcastle, C (2005) Integrated Assessment of Urban Sustainability, "Engineering Sustainability", volume 3, issue 7, 57-65.

Yin, R K (2003) "Case study Research: Design and Methods", 3rd edition, Applied social research methods series Vol 5, London: Sage Publications Ltd.

Mapping the knowledge flow during sustainability assessment within a university campus project

Dr Craig Thomson[1], Dr Mohamed El-Haram[2], Dr Rohinton Emmanuel[1]

1 – Glasgow Caledonian University, UK

2 – University of Dundee, UK

Increasingly, importance is being attached to the role of knowledge and the requirements associated with its flow during sustainability assessment. Acknowledged as a key barrier in the application of sustainability assessment, is the limited understanding amongst practitioners relating to the concept of sustainability and its implications for practice, in addition to the nature and requirements associated with the practice of its assessment. It is suggested that knowledge management can play a significant role in aiding knowledge transfer between stakeholders during an assessment, helping to create, through social learning, a common understanding of the actions required for a more sustainable urban environment and the role of assessment within this. Understanding the processes involved in the generation, flow and capture of knowledge within this context is key to aiding the overall management and facilitation of its application in practice.

Knowledge mapping is a technique that offers the potential to develop a better understanding of the nature and flow of knowledge during complex processes. This paper presents the findings of a knowledge mapping exercise that focused on understanding the nature of this flow during sustainability assessment through an empirical case study. The analysis revealed the key sources of knowledge that a key decision-maker draws upon during the four identified phases of sustainability assessment (identification of project sustainability issues, selection of an appropriate sustainability assessment tools, the implementation of the assessment tool and during the consideration of its outputs). Knowledge exists in a variety of types and forms, and the key sources were classified around an emerging set of categories relevant to the context in question. The mapping exercise identified the variations in the types of knowledge held by the different stakeholders during the assessment, and the mechanisms most effective in ensuring its transfer to the key-decision maker. This research highlights that whilst access to explicit forms of knowledge is necessary, it is when viewed together with the implicit forms of knowledge held by the rest of the team and wider stakeholders that the basis is provided for effective decision-making and a stimulus for the desired social learning. The value of implicit forms of knowledge such as expert and tacit knowledge are highlighted within the case study. Ensuring that these pathways are facilitated through effective management that delivers continued engagement between the key-decision maker, the rest of the team and wider stakeholders is therefore essential.

Keywords: built environment, implicit knowledge, stakeholder engagement, sustainability assessment

1 Introduction

Increasingly sustainability assessment is called upon to play a role in providing systems to assess and monitor sustainability so that decision makers can be regularly informed and guide development projects towards a sustainable path (Mitchell et al. 1995; Walton et al. 2005). The traditional view of sustainability assessment is as a technically based exercise focused on understanding and quantifying the flow of resources intended or actually used within a project, and this is increasingly criticised as it fails to align with calls for an increasingly proactive approach (Cole 2005; Thomson et al. 2009a). Many authors argue that assessment needs to evolve to engage with the predominantly subjective nature of decision-making surrounding sustainability within the project environment (Pahl-Wostl 2002; Lee 2006). The likes of Pope et al. (2004) and Cole (2005) argued that a traditionally reactive approach to assessment fails to play the desired role in creating an environment where stakeholders are forced to rethink their priorities through the examination of the potential impact of their project on sustainability. For sustainability assessment to evolve as a tool for instilling sustainability within decision-making, it requires to be viewed as an integrated element of the activities across the project (Lutzkendorf and Lorenz 2006). Through this, assessment aims to support decision-making by promoting discourse between stakeholders around the principles and implications of sustainability, by providing tangible information in a transparent and inclusive manner (Pope et al. 2004; Mathur et al. 2008). Establishing such an environment enables a shared understanding to emerge rooted around knowledge that is contextual to the project (Thomson et al. 2009b). Kaatz et al. (2006) argues that by promoting discourse during decision-making, assessment provides a role in stimulating a transfer of knowledge between stakeholders in a manner that promotes an understanding of their values and aids the establishment of a learning culture around sustainability within the built environment (Pope et al. 2004; Lee 2006).

The delivery of such an environment has so far been limited in practice, with many pointing to the absence of a common framework and language around which to consider and assess sustainability in an approach that is usable (Brandon et al. 1997, Deakin et al. 2002). Whilst the lack of a truly integrated tool for assessment has contributed to this problem, increasingly many are citing the lack of understanding amongst practitioners of the concept of sustainability, the nature of the assessment tools and the implications that these present to current practice, as restricting the opportunity for evolution (Mathur et al. 2008; Thomson et al. 2008). If assessment is to play a role in developing a wider appreciation, it is necessary to develop an improved understanding of the nature and flow of knowledge surrounding the assessment in order to facilitate its management and evolution in line with the desired approach (Khalfan et al. 2002; Wilkins 2003). Thomson et al. (2009a) suggested that applying the principles of knowledge management to the assessment context, has the potential to aid the understanding of the capture, storage and retrieval of knowledge considered and generated during an assessment. This has the basis to assist management of the generated knowledge, by developing appropriate mechanisms to facilitate its flow and transfer between relevant stakeholders involved in present and future assessments.

This research aims to contribute towards an emerging understanding of how sustainability assessment is applied in practice by mapping the flow of knowledge during the different phases of assessment across the project lifecycle of an empirically based case study. Knowledge mapping was adopted to identify the sources of knowledge considered during the phases of assessment, and to classify these around an emerging set of categories. This exercise aims to engage with the complex nature and flow of knowledge found within this context, by identifying the type of knowledge held by each of the stakeholders during the assessment and the mechanisms involved in its transfer to the key decision-maker. By considering a project that adopted a progressive approach to sustainability during assessment across the project lifecycle; some key lessons can be drawn to aid the evolution of sustainability assessment in practice towards the aspired approach.

2 Role of knowledge in the assessment context

Thomson et al. (2009a) suggested that knowledge management has a role to play in supporting the development of approaches to sustainability assessment in line with that advocated by the likes of Kaatz et al. (2006). Knowledge is primarily developed through its acquisition over time through experience with individuals acquiring it primarily through the sharing of experience with others through a variety of means and therefore stimulating learning (Matsumoto et al. 2005). Developing the knowledge base of a team is essential to its ability to successfully solve problems and make decisions (Salter and Gann 2002). By enabling stakeholders to experience the concept and application of sustainability principles and tools in practice through involvement in its assessment, it is suggested that the ability to understand and interact with its practical implications during decision-making is improved (De Geus1992; Wilkins 2003; Mathur et al. 2008). The success of this approach depends on the ability to effectively transfer knowledge between the various stakeholders, resting on the ability of those managing it to understand its nature and flow during engagement and contribution to the decision-making process. By considering the principles of knowledge management, the requirements for aiding the flow of knowledge generated during an assessment can be identified, therefore facilitating its acquisition by a wider group of stakeholders through its transfer (Thomson et al. 2007, 2008).

Kasvi et al. (2003) identified two basic strategies required to effectively manage knowledge- a personalisation strategy (where knowledge is seen as tied to those who develop it and is shared through personal interaction) and a codification strategy (based on codification of knowledge and storing it in artefacts and databases where it can be accessed). These strategies reflect an understanding that knowledge exists in various forms and requires methods of transfer that are appropriate for the context and stakeholders involved. The dominant types of knowledge are understood as either explicit or implicit by nature. Explicit knowledge is understood as that which is documented and public, structured, fixed-content, externalised and conscious (Egbu and Botterill 2002), and these tend to reside in books, documents, formulas, project reports, contracts, process diagrams, list of lessons learned, case studies, white papers, policy manuals etc (Vestal 2005). On the other hand implicit knowledge is dependent on contextualisation, is not codified, but can be captured and written down only once the full depth of the context is understood (Vestal 2005). If the flow of knowledge is to be improved, an understanding of these different types and forms of knowledge is required, and it is necessary to examine these in greater depth. A particular type of implicit knowledge that requires to be considered in the assessment context is the role played by tacit knowledge. This is understood as found in know-how, past experiences, expertise, found through interaction between individuals, and through the memories of others (Egbu 2004; Mohamed et al. 2006). It is important to appreciate the different types of knowledge, as they will contribute to the decision-making processes surrounding the assessment in different ways.

3 Case study background

An empirically based case study provided a suitable lens within which to examine the experience and interaction of those participating in sustainability assessment within an active development project. Real life examples permit the research to embrace the contextual nature of knowledge that is so important to understand within this context (Yin 2003). The case study project selected was for a new Institute of Medical Sciences at a UK university, to provide enlarged dedicated areas for medical research, biology teaching, chemistry teaching and photonics research. With planning permission obtained, preliminary works started in June 2008 with construction activities commencing at the start of July 2008 and a completion date targeted for January 2010. The project represents a progressive attempt to apply sustainability assessment in order to guide the decisions taken within the project relating to design and construction across the project lifecycle. Sustainability is clearly rooted within the University's governance processes and practices, and was captured within the institutions sustainability policy and outlined in the sustainability strategy. The client actively sought a project team that would work with them to deliver a sustainable build, by appointing team members who they had either worked with before or could demonstrate sustainability credentials. The project was procured using a two stage procurement strategy.

The client had applied BREEAM (Building Research Establishment Environmental Assessment Method) (BREEAM 2007) as a tool for sustainability assessment within previous campus projects, but felt initially that the criteria offered failed to reflect the sustainability requirements of this building. The appointment of a sustainability advisor based with BRE provided the team with the knowledge to reach an agreement to adopt a tool that is based on the development of BESPOKE assessment criteria that reflected the nature of the building and its specific requirements. The client demonstrated an awareness of the role that knowledge plays in effective decision making, by enabling experts such as the BRE and the Carbon Trust to contribute during the various phases of assessment, in order to enhance the existing knowledge of the project team. A project of this nature has a diverse range of stakeholders displaying a variation in interests and requirements from the building whether it be members of the project team, building users (academics, researchers, students, and facilities managers), local and business communities influenced by its construction and its operation. It is necessary to manage the flow of knowledge between these stakeholders during the different phases of the assessment in order to effectively integrate sustainability and its assessment with the decisions made within the project process. The findings of this research stressed the significance of an effective flow of knowledge between the activities of the assessment and the decision-making within the project. This was highlighted by the ability of the team to improve the BREEAM rating from an initial 'Very Good' and towards an 'Excellent' through effective feedback and recognition of its achievability in practice.

4 Methodology

Knowledge mapping is a technique that has been adopted commonly by multi-nationals to understand where knowledge resides in their organisations, its form and the nature of its transfer (Egbu 2004; Kasvi et al. 2003). When applied in this context, knowledge mapping provides the basis for understanding the requirements associated with the individual phases of sustainability assessment (identification of project sustainability issues, selection of sustainability assessment tools, implementation of the assessment tools, and consideration of tool outputs). During the analysis, techniques such as organisational network analysis (ONA) (Vestal 2005) were deployed under the principles of grounded theory (Strauss and Corbin 1990) in order that the nature of the relationship between the stakeholders is understood, identifying who is involved during an assessment, define what their role is, what knowledge they hold, what knowledge they require, and its preferred method of transfer. Grounded theory is an approach that aims to ensure any preconceptions from the researcher or theories established within other contexts were minimised, therefore allowing the analysis to be reflective of the situation found in practice. Knowledge mapping is a technique used to understand the different types of knowledge that requires to be managed within a context.

A series of semi-structured interviews were conducted with some members of the project team involved or influenced by the application of the sustainability assessment within the project. The interviews were split in two phases, the first to develop an understanding of the project, the approach to sustainability, and the different phases of sustainability assessment across the project lifecycle. As a result, an interview was conducted with an individual who could provide an overview of the project and its consideration of sustainability, from its inception and across the various stages of the lifecycle. In this case the University’s Environment and Energy Manager provided the required overview and understanding of the project. The second phase aimed to focus in detail on those who participated specifically in the sustainability assessment in order to gain a practitioners insight into the associated knowledge requirements, who is involved, what knowledge is required, who holds the knowledge, the nature of its flow and what mechanisms can be provided to aid its flow during a sustainability assessment. The interviews conducted during this phase were with the sustainability advisor, assessor and projects architect.

The paper presents three stages of analysis for each phase of the assessment; a description of the activities involved; the classification of knowledge sources using emerging categories during the research; and the findings of a knowledge mapping exercise for each source, pathway and receptor of the knowledge. The knowledge mapping techniques applied drew lessons from the work of Vestal (2005), Eppler (2008), and Egbu (2006). The overall approach is similar to Eppler's (2008) description of a 'knowledge application' approach, which focuses on the type of knowledge applied to a certain process stage, and follows Egbu's (2006) work by providing an understanding of the specifics of the knowledge (i.e. documents, databases etc) and observing the processes; roles and competencies of the stakeholders involved. It was apparent, that in order to engage with the contextual nature of knowledge flow within the assessment context, a tailored approach was required and that a mixture of representations would provide greater value than applying a single established technique.

5 Flow of knowledge by phase of assessment

Four key phases of sustainability assessment were identified within the research around which the key-decisions are taken i.e. identification of project sustainability issues, selection of sustainability assessment tools, implementation of the assessment, and consideration of tool outputs. The following discussion presents the findings of the knowledge mapping for each of phase. This section is supplemented by Thomson et al. (2009b) which explores in detail the assessment in relation to the project lifecycle and maps the nature of the involvement of the stakeholders.

5.1 Sustainability issues selection

The selection of project sustainability issues occurred through three stages, an initial meeting, the development of an initial report and a main meeting where the criteria was agreed. The initial meeting was set up between the project board, client representative and the sustainability advisor in order that the client side could outline their sustainability aspirations and requirements for the project to the advisor. The meeting provided the opportunity for the advisor to suggest additional criteria and advise on the implications of these aspirations for the development of the project. Following the initial meeting, the advisor produced a report to reflect how the emerging criteria for selecting the issues were aligned with legislative and policy requirements and the implications for the design of the building. This was designed to act as an aid for discussion during what was described as the main meeting, where after considerable discussion an initial criteria was established. Although the criteria of selected issues was revisited and amended following the selection of the tool and the supplementary criteria added at a later stage by the Carbon Trust, these stages formed the foundations for the BESPOKE criteria adopted.

During the analysis, a number of drivers emerged shaping the nature of the sustainability issues selected and therefore determining the relevant knowledge requirements. Strong drivers identified surrounded the planning context, regulation requirements, client requirements and stakeholder values. In this case study the strong sustainability agenda and policies of the University; in addition to its relationship with the town, acted as a strong context around each of these drivers. The key-decision maker required to consider the constraints of the project, issues of design and the context of the site prior to settling on the criteria. It was necessary to balance these against the vision and scope for sustainability within the project. In order to achieve this balance, the project board and client representative drew heavily on the sustainability assessor to provide expert advice and past experience to aid the development of appropriate and achievable criteria.

It is apparent that in order to support decision-making, different forms of knowledge require to be considered, and it is necessary to understand these variations in order that effective mechanisms can be developed to maximise its effective transfer. Classifying knowledge allows for differentiation to be provided between knowledge that is explicit by nature (i.e. document based), and that which is implicit (whether it be values and requirements of the stakeholders, expert knowledge, or tacit knowledge supported by individuals past experiences). In identifying and selecting the project sustainability issues, members of the team held and/or accessed a variety of different knowledge sources that were explicit and implicit by nature and these are displayed in figure 1. The figure reveals a set of categories which emerged during this research grouped around the two dominant types. Explicit knowledge was identified to group around planning and regulation documents, client based documents and project based documents. The implicit knowledge tended to group around the stakeholder values and requirements, expert knowledge, with tacit knowledge supplied by stakeholders surrounding sustainability and its assessment, as well as that which relates more to general practice.

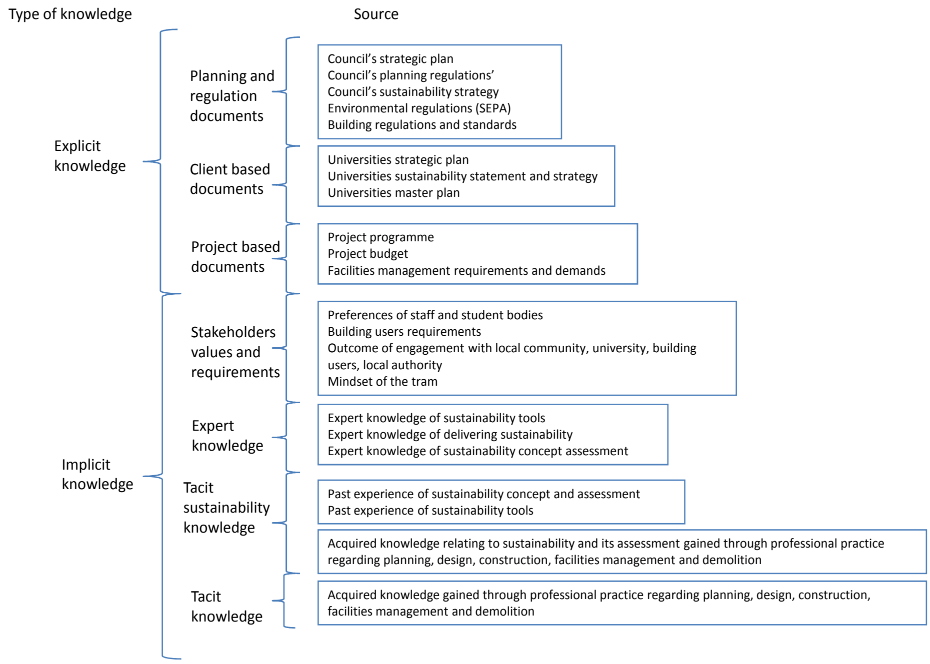


Figure 1: Classification of knowledge sources consulted during issues selection

The knowledge mapping exercise set out to map the flow of knowledge surrounding these knowledge sources and to identify the stakeholder's who hold it, the relevant pathway for its transfer, those acting as its receptor and to identify which of the drivers they are required to support. Table 1 provides an example of the knowledge held by the sustainability advisor, illustrating the nature of their role in supporting the decision-making. Highlighted is the implicit nature of the knowledge the advisor supplies such as the expert knowledge, their ability to place stakeholder values and requirements into context and the tacit knowledge gained through their previous experience.

Table 1: Classification of the knowledge held by the sustainability advisor during issues selection

Stakeholder	Knowledge type	Knowledge sources
Sustainability Advisor	Expert Knowledge	Expert knowledge of sustainability tools
		Expert knowledge of delivering sustainability
		Expert knowledge of sustainability concept and assessment
	Tacit Sustainability Knowledge	Past experience of sustainability concept and assessment
		Past experience of sustainability tools
		Acquired knowledge relating to sustainability and its assessment gained through professional practice regarding planning, design, construction, facilities management and demolition
	Tacit Knowledge	Acquired knowledge gained through professional practice regarding planning, design, construction, facilities management, and demolition

Displayed in figure 2 is an example of the outputs from a mapping exercise to identify the source, pathway and receptor for each of the knowledge sources considered during the selection of issues and an indicator of which driver they inform. The example is for tacit sustainability knowledge, and illustrates the flow from a range of stakeholders who display experience of sustainability as a concept, and its assessment in practice; and its flow through a range of formal and informal mechanisms with the client body to support their decision-making.

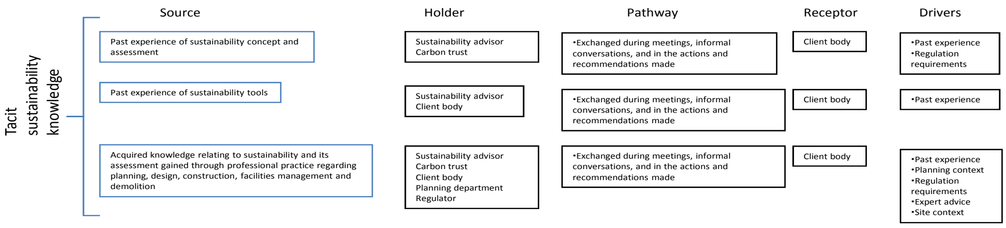


Figure 2: Source, pathway and receptor of tacit sustainability knowledge consulted during issues selection

The client representative and the project board relied heavily on the expert advice of the sustainability advisor and latterly the Carbon Trust to guide them through the process, by assisting them to reflect planning, regulations, stakeholder requirements with selected issues reflective of the context of the project. Expert advice about sustainability as a concept, the nature of the tools, and in delivering sustainability in practice, proved extremely valuable in guiding the client representative and project board during selection. Another area of significance was the role of tacit knowledge drawn from the past experience of team members regarding sustainability, assessment and the tools, in addition to the general levels of knowledge that has been acquired by individuals through their profession and everyday lives.

Knowledge mapping can take a number of different forms emphasising specific aspects of the flow of knowledge. It is often beneficial to provide a number of alternative representations of the same phenomena in order to aid the level of understanding. The knowledge maps were developed based around the identified ‘drivers’ for selecting project sustainability issues. Figure 3(a) shows examples of this illustrating the flow surrounding the drivers 'planning context, regulation requirements and client requirements' from the key-decision maker, the sources of knowledge and the stakeholders from whom this knowledge. The key shown in figure 3(b) illustrates the nature of the explicit transfer of knowledge (i.e. through documents) and the implicit transferred through a mix of formal (i.e. project meeting) or informal (i.e. telephone conversation) pathways between the stakeholders. This kind of map is potentially easier to interact with.

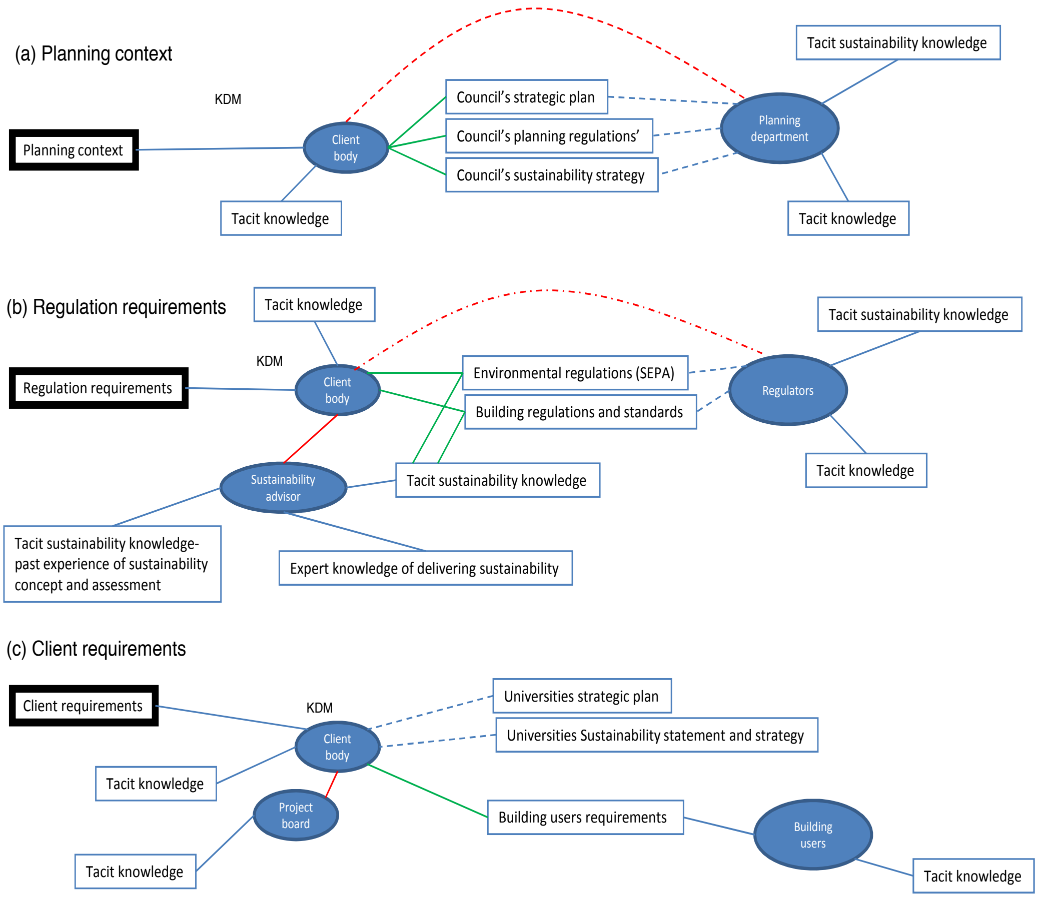


Figure 3a: Knowledge map of the key drivers during issues selection

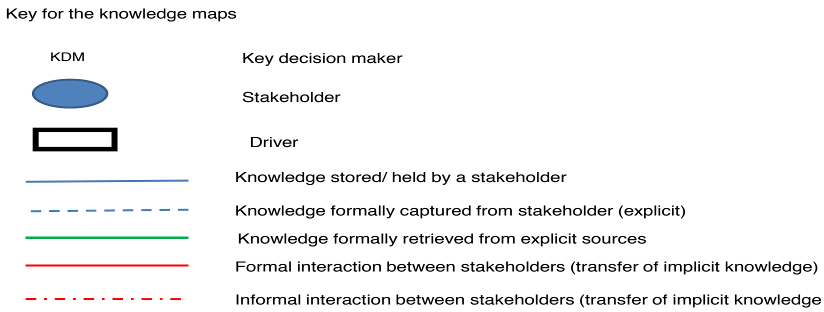


Figure 3b: Key for the knowledge maps

5.2 Tools selection

The application of BREEAM as an assessment tool in previous campus projects meant that the project board and client representative approached the selection of tools with an understanding of its implications for practice. Indeed, the experience gained from these projects resulted in the project board displaying initial reservation to the selection of BREEAM for this project. It was apparent that the stages observed in selecting the sustainability tool were tied heavily to those of selecting the issues with an initial meeting, the development of an initial report and a main meeting where the criteria of issues was agreed. Considered in tandem during these stages was the question of which tool to select, how the emerging sustainability issues fit with those considered in a tool like BREEAM, and how the BREEAM criteria can inform the selection of issues. Following the emergence of a set of project sustainability issues during the initial meeting, the sustainability advisor prepared a report which considered how these can relate to the established BREEAM criteria. The project board were concerned that the context of the project required slightly different criteria, and had experienced difficulties making the BREEAM criteria work to reflect the often unique nature of campus buildings. The advisor concluded that BESPOKE criteria should be developed to support the BREEAM criteria by addressing the sustainability issues which the project board felt it otherwise did not address. The sustainability advisor, in addition to suggesting suitable criteria to the project board during the main meeting, used it to convince the team that supporting a BREEAM assessment in this manner was an effective way to accommodate their concerns. The different assessment ratings that can be achieved were also discussed, and consideration was given to the implications of these on the development of the project. A decision was taken to peruse a ‘Very Good’ BREEAM rating, however the capacity was provided for a higher rating if it was found to be possible to achieve at a later stage of the project. The team accepted the recommendations, and the sustainability advisor began to prepare a pre-assessment report outlining the expected rating and individual targets required to achieve this.

Given the iterative nature of the first two phases of the assessment many of the drivers identified were the same. Additional drivers related to funding requirements and the potential for market advantage and publicity for the project, were identified as considerations during the selection of the tool. In this case, the use of BREEAM was not a requirement for funding allocation specifically; however it was felt by the university that the use of such a tool would help to demonstrate an understanding of the sustainability credentials of the campus within the community. The selection of tools is influenced heavily by the trends and agenda of the industry, and in this case the project board felt comfortable in the application of the tool as they could see its implementation by their contemporaries increasingly as an industry standard. Tools present challenges to the project's delivery and these vary depending on the tools. The sustainability advisor was able in this case to provide the required knowledge regarding the implications of using BREEAM in the project, with particular focus on its suitable application across the lifecycle of the project.

In identifying and classifying the knowledge sources drawn upon during the selection of the tool, a structure emerged illustrating a strong reliance on a variety of knowledge types, from explicit knowledge such as documents and reports, to various forms of implicit knowledge. The findings are presented in figure 4. In this case an additional category for explicit knowledge emerge of organisational data bases, which were drawn upon by some of the organisations to learn lessons from the application of tools in previous projects. It is apparent that the role of the sustainability advisor played a significant role in aiding the decision-making process through the range of knowledge sources that sustainability advisor expertise was able to provide. In addition, the project board and client representative were able to drawn on considerable tacit knowledge gained through the experience gathered from previous campus projects which had used BREEAM as a tool before. These varied types of knowledge sources contributed heavily to aid the decision-makers to select an appropriate tool and suitable rating for this project.

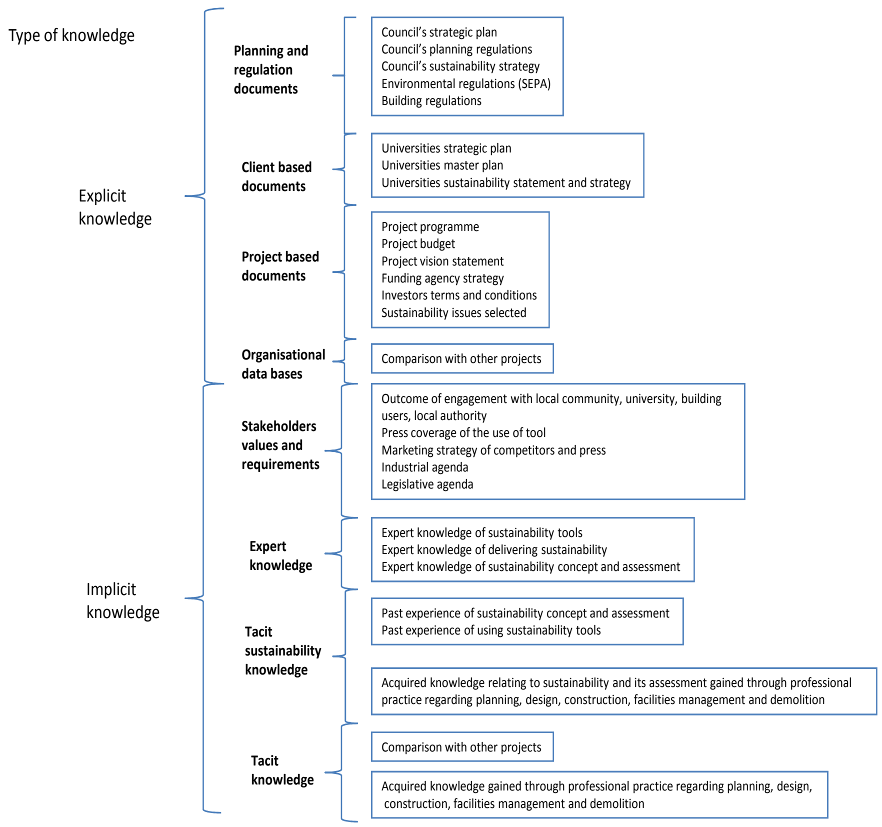


Figure 4: Classification of knowledge sources consulted during tools selection

Knowledge mapping was conducted using the same techniques as displayed in table 1, figure's 2 and 3; revealing the use of a range of formal and informal mechanisms for transferring these different sources of knowledge. Illustrated were the varied forms of these mechanisms and the significance of not only the explicit knowledge sources but the support and contribution made by implicit knowledge sources in supporting decision-making during tool selection. In many cases it emerged that the key-decision maker would consider explicit sources in the form of written documentation but to support its interpretation or even by pass it, by asking formally or informally those who had generated or displayed an understanding of it. In this context, the key-decision maker displayed an ability to understand their own knowledge strengths, but also of their weaknesses and highlighted a willingness to support this by asking the relevant experts.

5.3 Implementation of the assessment

The implementation of the assessment was the responsibility of two individuals; the sustainability advisor to oversee the assessment of the additional BESPOKE criteria, and a sustainability assessor employed to oversee the management of the BREEAM assessment. Following the appointment of the assessor, a meeting with the design team was organised to outline the BREEAM criteria, the additional BESPOKE criteria and the means by which the evidence would be collected and managed. The design team were given time to consider the implications of the criteria in relation to their practices and the issues associated with providing the evidence in the correct form. A follow up meeting was organised, for the sustainability advisor, assessor and design team to consider the implications of achieving the desired rating of 'Very Good'. During the design phase, the sustainability advisor and assessor oversaw the management of the collection of evidence from the design team and supporting consultants. This was an iterative process to a certain extent, with the individual criteria being monitored and changes made to ensure that the rating is achieved in practice. It was this process, which provided the awareness amongst the team that an 'Excellent' rating was a possibility, enabling the decision to be taken to peruse it. The sustainability advisor and assessor compiled the evidence of their respective criteria into an initial report and then shared it with the rest of the team.

The classification of knowledge sources considered during the implementation of the tool are displayed in figure 5. The explicit knowledge sources focused on project based documentation outlining the project programme, budgets, and performance which to a large extent define the context around which the assessment is managed. However, it was apparent that during this phase that a reliance was observed on implicit knowledge sources with considerable influence exerted by the attitude, values, mindset of the project team (stakeholders) and their ability (knowledge and experience) to engage with the assessment. If those managing the assessment can recognise and understand the nature of these attributes within the team, they can develop an approach to manage the assessment that responds to these needs. The project board recognised the value of supporting this process by employing an expert to develop a suitable infrastructure, run the assessment and to be accessible to provide advice to the design team across the process. Heavily influential was the level of tacit knowledge that supports the delivery of the assessment, as the design team demonstrated considerable past experience of BREEAM assessments within previous projects.

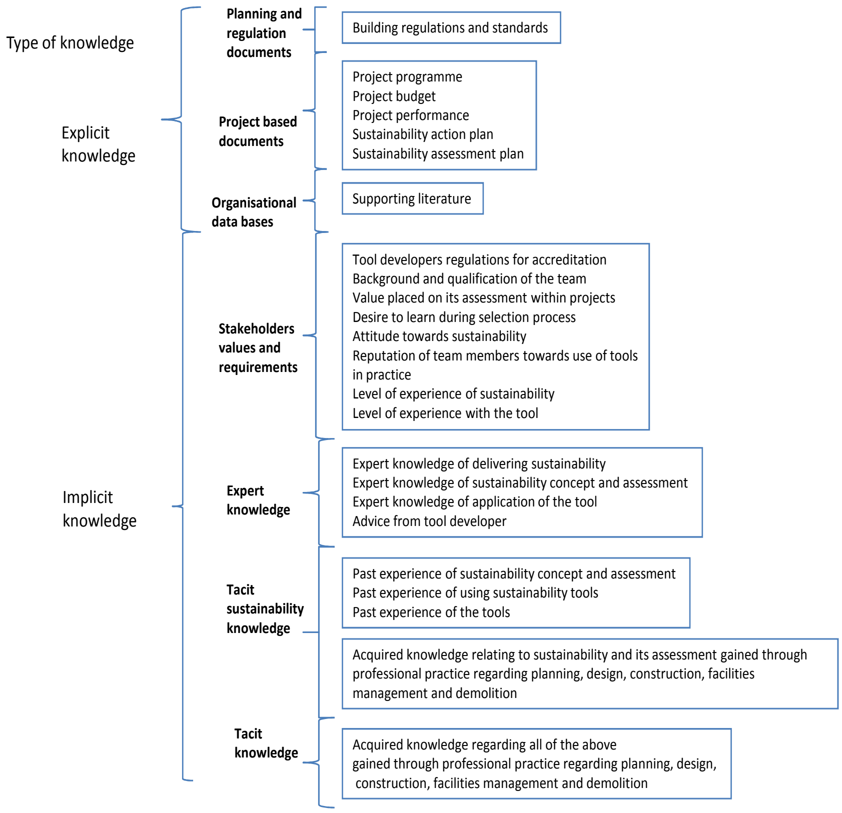


Figure 5: Classification of knowledge sources consulted during the implementation of the assessment

The knowledge maps highlighted the dominance of the implicit forms of knowledge and the nature of the pathways as largely focused on ensuring that the assessment is supported by knowledge from those with expertise and past experience of assessment. For example, the project board employed a sustainability advisor and assessor to assist decision-making, and to aid the understanding of those involved in the gathering and collation of data and evidence. The interaction required to deliver this took place during a range of formal meetings and through informal discussions in order to facilitate this transfer of knowledge by providing access between those who hold it and those need to receive it. The same pathways are important for aiding the transferred of the past experiences held by the team identified as so important during this process.

It is possible to identify the dominance of the formal or informal transfer of implicit knowledge to the key-decision maker. Explicit forms of knowledge are important, but of significance are the formal and informal pathways involved in the transfer of knowledge from those holding the expertise or past experience with those who require it. As a result, engagement was required to assess these attributes in order that suitable management support can be provided i.e. training. All the members of the team outlined their desire to learn, and this case demonstrates the importance of allowing team members to access and enable participation in the assessment. This was demonstrated to facilitate learning from one and other, and through the process of doing assessment in practice. The reliance on the transfer of implicit knowledge to support this highlights, the role of social learning in aiding the development of an individuals knowledge base, allowing them appreciate the role of assessment and how it relates to the particular nature of their own professions and roles.

5.4 Consideration of its outputs

Following the development of the initial report, one of the priorities for the project board is to ensure that the outputs of the assessment tools are communicated effectively with a broad range of stakeholders. The sustainability assessor circulated an initial BREEAM assessment report through email and paper copy to the relevant individuals of the project team. This was supported by the provision of a similar report by the sustainability advisor for the BESPOKE criteria and this was distributed by e-mail to relevant team members. A specific project meeting was arranged to begin to consider the implications for the emerging outputs on the project, enabling the team to discuss the outputs with a view of the remainder of the project process and to devise a dissemination strategy to wider stakeholders. The sustainability assessor prepared a formal report for submission to the BRE for accreditation, with the advisor developing a report for the Carbon Trust relating to their specific criteria, but also a project focused report considering the BESPOKE criteria. The final BREEAM report emerged in two forms as a technical report and a rating certificate. The nature of the audience for these two forms, varies as they play two distinct roles. The technical report is developed initially to provide the BRE with the evidence to award a rating, but is of value for members of the project team with the technical knowledge to make sense of it. On the other hand, the rating certificate is used to communicate the final award rating to wider stakeholders such as local community, users of the building, local authority, future clients etc. The Carbon Trust report is a technical based report that is submitted to the Carbon Trust and considered as part of the University's Carbon Management Programme.

Classifying the knowledge sources required to support the consideration of tool outputs revealed the variety of knowledge types which contribute towards this process and is displayed in figure 6. Explicit forms of knowledge relating to planning and regulation requirements were observed in relation to the extent that the outputs comply with these. In this case, this was not a significant issue but they were still considered. Documents relating to the requirements of the client were also consulted to ensure that the assessment satisfied the expectations of the university. This was mirrored by the consideration of the project documentation to insure that the emerging outputs reflected the agreed targets and expected performance. Whilst these documents were valuable to consult, it was clear that implicit knowledge sources played a heavier role in supporting the process of considering the assessment outputs, due mainly to the subjective nature of this process. Within this context, the project board paid attention to the values and requirements of the stakeholders, given the importance this plays in identifying a suitable route for dissemination. The project board relied on their own experience, in addition to the expert knowledge and past experience of the sustainability advisor and assessor to decide the most effective means of communicating the outputs to the different groups of stakeholders with their contrasting knowledge requirements. The sustainability advisor and assessor provided an understanding of how the rating achieved related with other projects they had either worked on or projects that they were aware of. This expertise provides the university with the confidence and legitimacy to market the fact that the assessment had produced an 'Excellent' rating.

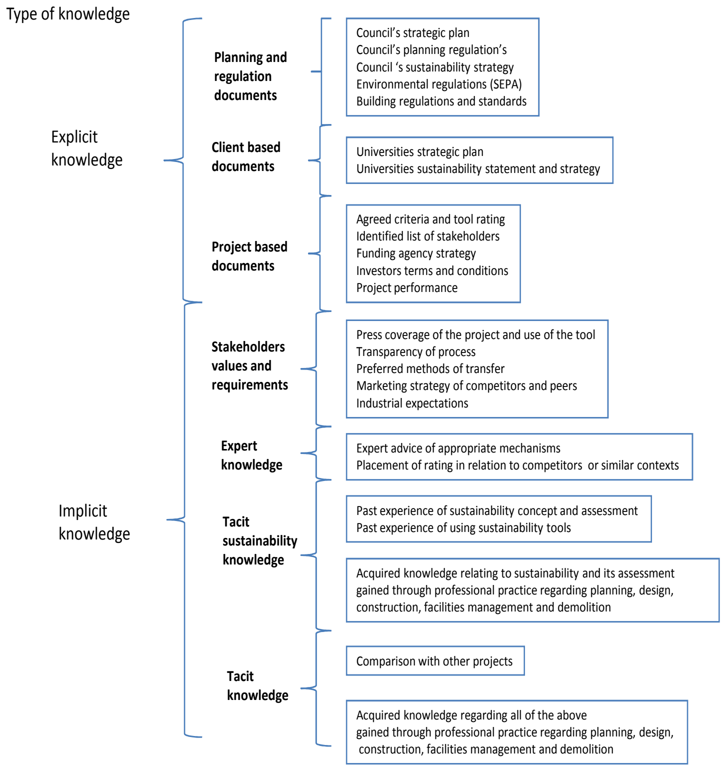


Figure 6: Classification of knowledge sources consulted during the consideration of the tool outputs

The subjective nature of the decisions surrounding the outputs of the assessment tools required a variety of different pathways to facilitate the flow of knowledge. Explicit documents relating to the planning context and relevant regulations were consulted directly, with further consideration facilitated through informal discussions with the relevant body. This enabled the project board to view the outputs of the assessment in relation to this context. A similar approach was witnessed through the consultation of the client and project based documents, and this was supported through formal project meetings and a series of informal discussions between those who required the knowledge and those who held it. These pathways allowed for the project board to deliberate the implications of the assessment outputs in relation to expectations and to come to suitable conclusions. Access to these discussions was provided to a range of project team members, in order that the implications of the assessment can be considered widely, and taken into account during the later stages of the project lifecycle (i.e. construction and operation).

The pathways supporting the transfer of implicit knowledge reflected a variation in the nature of the knowledge sources. The project board required to consider a dissemination strategy to communicate the outputs, and therefore needed to understand the varying requirements and preferences of the different stakeholders. This understanding was established through a variety of pathways ranging from informal discussions with relevant stakeholders or a review of other projects to consider their dissemination strategies. Key was the support of the expert knowledge and past experience drawn on by the sustainability advisor and assessor. The project board recognised this need, and involved these individuals in the discussions directly.

The project board recognised the value of learning as much as possible from the project, for the benefit of the later project stages, but also to take the lessons learnt and to apply them during future projects. Understanding the implications of the assessment outputs was key to this process, and through the maps it is possible to understand the role that the sustainability advisor and assessor play in this process.

6 Conclusions

The research displays the finding of a knowledge mapping exercise, presented through a range of techniques to highlight the diversity of knowledge sources considered the key decision-makers during each phase of assessment. Presented are a variety of knowledge types and a diversity of stakeholders who hold and receive this knowledge. Explicit knowledge was identified to provide the context around which such decisions are founded, with awareness and access to the relevant documentation observed as necessary. However, the analysis stressed the significance of ensuring that this was supported through the exchange of implicit knowledge to provide the necessary contextualisation with the requirements of the project. Particular emphasis is placed on the knowledge provided through advice by experts or those with past experience. The project board within this case study demonstrated an awareness of the value of expert and tacit knowledge as a contribution to the largely subjective decision-making process that surrounds each of the phases of assessment. This is illustrated by the involvement of a sustainability advisor throughout each phase and the prominent role played by the sustainability assessor, in contributing to the decision-making process and in managing the application of the assessment in practice. The project board recognised the value of different pathways to facilitate the flow of knowledge, whether they are through the employment of expertise directly from a consultant, or through its formal transfer during project meetings or workshops, but also through its transfer informally during individual conversations.

Ensuring that the flow of knowledge is facilitated through effective management is key to ensuring that sustainability assessment evolves in the advocated manner. If assessment is to emerge as a tool to aid the integration of sustainability within project activities, stakeholder mediation and learning the continued engagement between the key-decision makers, the rest of the team and wider stakeholders is essential. The case study illustrated the benefits of this by supporting decision-making through the facilitation of the knowledge flow regarding sustainability and its assessment as widely within the project team as appropriate. This allowed the team to demonstrate a high capacity for social learning about both sustainability as a concept and its assessment, and this was best demonstrated in this case through the ability of the team to recognise the opportunity to raise the targeted BREEAM rating during the design process.

7 Acknowledgements

This research would not have been possible without the willingness of the project team to contribute and spend time with the research team. The authors also gratefully acknowledge the financial support of the UK EPSRC (grant reference: EP/C008030/1) and the contribution of all the participating researchers from Dundee, Glasgow Caledonian, Loughborough and St. Andrews Universities who make up the SUE-MoT research consortium.

8 References

Brandon, P S, Lombardi, P L and Bentivegna, V (1997) "Evaluation of the built environment for sustainability", London: E & FN Spon.

BREEAM (2007) "Building Research Establishment Environmental Assessment Method", tool website: www.breeam.org (accessed 31 December 2008)

Cole, R (2005) Building environmental assessment methods: redefining intentions and roles, "Building Research & Information", volume 33, issue 5, 455-467.

Deakin, M, Huovila, P, Rao, S, Sunikka, M and Vreeker R (2002) The assessment of sustainable urban development, "Building Research & Information", volume 30, no 2, 95-108.

De Geus, A (1992) Modelling to predict or to learn? "European ER Journal of Operations Research", volume 59, no. 1, 1–5.

Egbu, C O (2006) "Knowledge mapping and bringing about change for sustainable urban environments: a report of a transition project research funded by the EPSRC Sustainable Urban Environment Programme (EP/C009649/1)", BNE No. 25, Glasgow Caledonian University, ISBN: 1-903661-92-7: http://www.sue-km.org/tpr.pdf (last accessed 25 January 09)

Egbu, C O (2004) Managing knowledge and intellectual capital for improved organisational innovations in the construction industry: an examination of critical success factors. "Engineering, Construction and Architectural Management", volume 11, no. 5, 301–315.

Egbu, C O and Botterill, K (2002) Information technologies for knowledge management: their usage and effectiveness. "ITcon", volume 7, 125–136.

El-Haram, M, Walton, J S, Horner, R M W, Hardcastle, C, Price, A, Bebbington, J, Thomson, C S and Atkin-Wright, T (2007) Development of an integrated sustainability assessment: In Horner, R M W, Hardcastle, C, Price, A, Bebbington, J (Eds) Proceedings of the International Conference on Whole Life Urban Sustainability and its Assessment, Glasgow, June 2007.

Eppler, M (2008) A Classification of Knowledge Maps, in: Lytras, M D, Russ, M A, Naeve Maier, R (Eds) "Knowledge Management Strategies: A Handbook of Applied Technologies", Idea Group, 117-143.

Kaatz, E, Root, D S, Bowen, P A, and Hill, R (2006) Advancing key outcomes of sustainability building assessment, "Building Research & Information", volume 34, no 4, 308-320.

Khalfan, MA, Bouchlaghem, DM, Anumba, CJ, and Carrillo, PN (2002) A Framework for Managing Sustainability Knowledge- The C-SAND Approach. "E-Sm@rt conference 2002: Towards a European Knowledge Economy in the Construction and Related Sector ", Salford, UK, 19-21 November 2002.

Lee, N (2006) Bridging the gap between theory and practice in integrated assessment, "Environmental Impact Assessment Review", volume 26, issue 1, 57-78.

Lutzkendorf, T and Lorenz, D P (2006) Using an integrated performance approach in building assessment tools, "Building Research & Information", volume 34, no 4, 334-356.

Mohamed M., Stankosky M. and Murray A. (2006) Knowledge management and information technology: can they work in perfect harmony? Journal of Knowledge Management, volume 10, no 3, 103–116.

Mathur, V N, Price, A D F and Austin, S (2008) Conceptualizing stakeholder engagement in the context of sustainability and its assessment, "Construction Management and Economics", volume 26, issue 6, 601-609

Matsumoto, I T, Stapleton, J, Glass, J, and Thorpe, T (2005) A knowledge-capture report for multidisciplinary design environments. "Journal of Knowledge Management", volume 9, no. 3, 83–92.

Mitchell, G, May, A, and McDonald, A (1995) PICABUE: a methodological framework for the development of indicators of sustainable development, "International Journal of Sustainable Development World Ecology", volume 2, no 2, 104-123.

Pahl-Wostl, C (2002) Towards sustainability in the water sector- the importance of human actors and processes of social learning. "Aquatic Sciences", volume 64, 394- 411.

Pope, J, Annandale, D, Morrison-Saunders, A (2004) Conceptualising sustainability assessment, "Environmental Impact Assessment Review", volume 24, 595-616

Salter, A, and Gann, D (2003) Sources of ideas for innovation in engineering design. "Research Policy", 32, No. 8, 1039-1324.

Straus, A and Corbin, J (1990) "Grounded Theory in Practice", London: Sage publications Ltd.

Thomson, C S, El-Haram, M A and Hardcastle C (2009a) Managing knowledge during urban sustainability assessment, Proceedings of the Institute of Civil Engineers, Engineering Sustainability, volume 162 issue 1, 35-44.

Thomson, C S, El-Haram, M A and Emmanuel R (2009b) Mapping sustainability assessment in relation to the project lifecycle of an university campus project, In Horner, R M W, Emmanuel, R, Price, A, Bebbington, J (Eds) Proceedings of the Second International Conference on Whole Life Urban Sustainability and its Assessment, Loughborough, April 2009.

Thomson, C S, El-Haram, M A, Hardcastle, C and Horner, R M W (2008) Developing an urban sustainability assessment protocol reflecting the project lifecycle. In: Dainty, A (Ed) Procs 24th Annual ARCOM Conference, 1-3 September 2008, Cardiff, UK, Association of Researchers in Construction Management, 1155-1164.

Thomson, C S, El-Haram, M, Walton, J S, Hardcastle, C, and Sutherland, J (2007) The role of knowledge management during urban sustainability assessment: In Horner, R M W, Hardcastle, C, Price, A, Bebbington, J (Eds) Proceedings of the International Conference on Whole Life Urban Sustainability and its Assessment, Glasgow, June 2007.

Vestal, W (2005) "Knowledge mapping- the essentials for success", Houston, US:APQC publications.

Walton, J S, El-Haram, M, Castillo, N H, Horner, R M W, Price, A D F and Hardcastle, C (2005) Integrated Assessment of Urban Sustainability, "Engineering Sustainability", volume 3, issue 7, 57-65.

Wilkins, H (2003) The need for subjectivity in EIA: discourse as a tool for sustainable development. "Environmental Impact Assessment Review", volume 23, 401-414.

Yin, R K (2003) "Case study Research: Design and Methods", 3rd edition, Applied social research methods series Vol 5, London: Sage Publications Ltd.

Spatial information infrastructure and tracking and tackling urban inequalities in India

Dr Tara van Dijk[1], Dr Christine Richter[2]

1 – University of Amsterdam, Netherlands

2 – International Institute for Geo-Information Science and Earth Observation, Netherlands

This paper is a status report on our research program focusing on how urban governance networks can tackle urban inequalities in Indian cities by using local spatial information infrastructure (SII). Our project integrates two main research questions: (1) what are the 'profiles' of inclusion, exclusion, and adverse incorporation regarding household access to requisite livelihood resources and what are their spatial concentrations, and (2) what are the obstacles that prevent a SII from becoming more locally embedded and institutionalized in content and as platform for use by urban governance networks? The project goals are both scientific and developmental. Scientifically, it will help build a spatially disaggregated model of household deprivations and the inequalities in access to and provision of livelihood resources. Also, it represents an evolution of the contemporary livelihoods approach as it strives to better account for the institutional and relational aspects of urban deprivations and their geography. Developmentally (based on close cooperation with local authorities and community organizations) this work could provide relevant contents for localized spatial information infrastructure initiatives. It is hypothesized that improved locally derived content and spatial disaggregation of deprivations (along with close attention to the types of institutionalized relationships that dominate low-income groups access to needed livelihood resources) will help poverty alleviation programs and city governance target better in terms of location, groups, sector, and needed institutional reforms. First, drawing on the concept of the 'installed base' we discuss the importance of determining the current status and actions of the human and technical resources which could serve as the foundation of a SII that can tackle urban inequalities. Then we discuss the political and ontological barriers that need to be considered while developing this approach. Ontologically, there are issues between how different stakeholders conceive of poverty, inequality, and SII. Politically, there are issues around the type of data collection and sharing this approach requires as civil society organizations, politicians, and bureaucrats are as likely to be adversaries as allies. Also, it is unknown to what extent this sort of SII can alter the present modus operandi or to what extent it ends up being compromised by it. This is because the normative goals of democratizing, rationalizing and technologizing urban planning can be undermined by stakeholders who benefit politically or economically from maintaining the grayness, ambiguity, and decision making monopoly present in these areas. Lastly, we will address how in an era where political space is dominated by a neoliberal governance logic, it is unclear how viable an approach with quality of life and equitable access to collective resources as implied goals can be.

Keywords: entitlements, institutions, spatial information infrastructure, urban governance, urban inequality

Introduction

We designed methods to map the spatial concentrations and diversity of urban deprivations based on a household perspective (Baud et al, 2008). An index of multiple deprivations (IMD) was constructed by employing the livelihoods approach[1] (looking at household levels of human, social, physical, and economic capital) and data from the Indian Census 2001, disaggregated to the level of electoral wards. This method offers an outcome map, if you will, that shows the results of present urban governance—in terms of the spatial distribution of wellbeing, privilege, and deprivation. Our current project takes this analysis further along two paths. One path is to link urban deprivations to the institutional environment (responsible for welfare creation and distribution) households must navigate when attempting to secure or improve their livelihood resources. To do this livelihood resource providing and intermediary organizations and networks present in our research sites will be analyzed in terms of the constraints and opportunities they pose for the development of household resources, claims and entitlements. These organizations and networks will be analyzed by both the supply-side and the demand-side perspective with the institutional environment seen as intermediating between the two. The second path is to explore how a spatial information infrastructure (SII)[2] can become a useful tool for urban governance networks[3] to better tackle urban deprivations sustainably. This requires fleshing out the possibility for instituting and scaling up SII based upon locally derived data on urban deprivations. The paper will proceed as follows: first we discuss SII in relation to urban governance, then we outline the strategic-relational livelihoods approach (SRLA) that will be applied to garner supply and demand side perspectives, and lastly we will outline our approach for discerning the opportunity context for an inequality tackling SII.

SII and Urban Governance

It is believed that more and better information can lead to more efficient planning and decision making, and subsequently more effective urban governance in terms of inclusivity. Several SIIs have been developed for the purpose of sharing expensive geospatial data and ready access to spatial information to support multiple purpose decision-making at different scales of governance. In many cases however, these are top-down approaches. Most follow either a technological or managerial imperative in design and implementation, with an outspoken focus on data, implying a preoccupation with aspects of data standards, interoperability, metadata (Georgiadou et al, 2005) and technology, while neglecting social, political, historical and institutional conditions within which such an SII should be embedded for effective utilization in urban planning. In particular, substantive issues are framed as technical or managerial problems needing similar solutions. People are considered 'universally rational agents' amenable to rational management methodologies, while information technology is assumed to be a value-neutral, globally enabling, and ahistorical mediator. The Indian national SII project, launched in 2001, is a prime example of a top-down approach to SII design and implementation, promoted by Indian elites and underpinned by a technological imperative (Georgiadou et al, 2005). According to Georgiadou et al (2005) the existing 'installed base' (Hanseth & Monteiro, 1998) (aka the existing socio-technical network) is often not considered in the overall design and metadata standards are created without an adequate perspective on their relevance and acceptance in local contexts.

We propose an analytical framework describing the potential role of SII in making urban governance networks more effective in tackling urban deprivations. What is needed is geo-referenced information on supply and demand side perspectives and the intermediating institutional environment disaggregated (when

[1]Livelihoods approaches offer a people-centered, forward looking, and holistic way of looking at urban inequalities (Rakodi 2002 & Moser 1998). They are people-centered and holistic because they do not focus on income poverty lines or economic growth or decline, rather they focus on household assets or 'capitals' and what they are able to do with these in their present situation. They are forward looking as they tend to focus less on what families do not have and more on what they do have and focus on ways to make household assets more secure and productive by making households more resilient to vulnerability (asset loss due to death, illness or market changes) (Moser 2006).

[2] SII is a socio-technical construct that mediates the development, access and exchange of information and reflect the relationships between the different actors.

[3] The responsibility for socio and economic development has moved from being the purview of the state to being shared by the state along with private sector firms and civil society organizations. Thus government becomes governance which refers to the processes of how governance actors work and interact to determine both different groups and areas' entitlements and correlative duties as well as to plan for the future.

possible) to the lowest political scale-level. A SII *could* provide basic overall and dis-aggregated information on deprivations that households face, the uneven geography of provision and access, and support strategic choices for prioritizing particular localities, sectors, and households. It must be noted that this type of SII rests on several problematic assumptions: that urban governance networks possess mandates to tackle urban inequalities and that a social justice ethos, more so than an entrepreneurial consumer-citizen or zero-sum game one, orients and coordinates the actions of governance actors (Harvey 1989; 1995). Politically, there are issues around the type of data collection and sharing this approach requires as civil society organizations, politicians, and bureaucrats are as likely to be adversaries as allies. Also, it is unknown to what extent this sort of SII can alter the present modus operandi or to what extent it ends up being compromised by it. This is because the normative goals of democratizing, rationalizing and technologizing urban planning can be undermined by stakeholders who benefit politically or economically from maintaining the ambiguity and decision making monopoly often present in urban planning and resource distribution. It is unclear at this time how viable an approach with quality of life and sustainable and equitable access to collective resources as implied goals can be. However, it is our position that while not wise to define what is sustainable and just *a priori* that an SII informed by the IMD and SRLA can help marginalized groups and their allies negotiate more just forms of inclusion by helping them combat exclusion, privilege and adverse incorporation. In this sense, it can be viewed as a useful tool for those interested in more socially just forms of sustainable urban development.

SRLA

Tackling urban deprivations effectively cannot be done by means of a traditional style SII since it requires specific knowledge regarding the local context and the spatial patterns of household deprivations. Accordingly, content development is guided by the following question: What kind of information is required to address urban inequalities in socio-spatial terms?

Within international development studies urban inequalities are understood to be multidimensional and research now focuses on the range of deprivations households cope with. A recent description of urban deprivations includes: inadequate and unstable incomes, inadequate, unstable or risky asset bases (such as lack of education and housing), inadequate provision of public infrastructure (piped water, sanitation, drainage, roads and footpaths), inadequate provision of basic services, limited safety nets for those unable to pay for services, inadequate protection of poorer groups through laws and rights, and powerlessness of poorer groups within political and bureaucratic systems (Mitlin and Satterthwaite, 2004). These deprivations clearly indicate that inequalities stem not only from a lack of work and income but also from problematic power relations rationalized or naturalized by the institutional environment—environments that make it difficult for certain groups of households to meet their own needs and gain access to collective provision. While livelihoods approaches can describe the condition of poverty, inequality, or wellbeing households face, it (as is) can tell us very little about the spatial and institutional factors. Regading the spatiality of urban inequalities—citywide measurement has rarely been possible due to lack of spatially dis-aggregated information on its multiple dimensions. To rectify this we developed the IMD which can be mapped within a geographical information system (GIS). This method makes it possible to identify 'hotspots' of poverty, wellbeing, and privilege for further analysis.

It is necessary to analyze both the supply and demand side perspectives as they relate to deprivations. The evolving sociological approach to poverty and inequality posits that inequality, "is the consequence of social relations, perhaps of exclusion, the withdrawal of protection, 'adverse incorporation' or exploitation — or the categories through which people classify and act upon the social world" (Harriss 2006). In other words, the relational-institutional aspects need to be fleshed out. We need to pay more attention to the relationships households engage in across the institutional environment (family, community, state, and markets) responsible for providing welfare. The extent households face exclusion and adverse incorporation or enjoy inclusion or privilege can only be better assessed through careful ethnographic analysis which looks for the ways some groups or areas' vulnerability is related to other groups or areas' security and privilege and the institutions which strategically regulate these uneven livelihood outcomes.

Broadly social scientists study institutions—the socially constructed rules and norms of human interaction that give a degree of continuity and predictability to social relationships—to look for the structural determinants[4] of individuals and groups' economic, political, and social behaviour. Studying the institutional aspects comprises both looking at concrete manifestations such as organizational and network forms, constitutions, policies, and outcomes, as well as the cognitive models hardwired via socialization that shape people's perceptions and actions. Like a game is played, institutions are lived and thus come most clearly into view in action. Reading the bylaws or policies of an organization (when available) can give one some idea of how players within the organization interact with each other, how the organization is to interact with other organizations, and how its members are to engage with clients, customer, or citizens and to what overall purpose. However, it is only by focusing upon actions and perceptions that one can begin to explicate how actors creatively (by necessity or choice) negotiate institutions, what rules and norms are dominant, why and to whose benefit and detriment. This means that much of what makes up institutions is one remove away from what we can observe (Bourdieu qtd. in Wacquant 2008 p.225). Thus, we must rely on proxies, namely organizations, social networks and social relationships—their form and function and individual actors practices and rationale for their practices. In particular we focus on the following aspects: authoritative labelling (Wood 2007), rules of entitlement (Bastiaensen et al 2002), and political space (following Hickey 2005 and Ferguson et al 2007).

To ground the institutional environment and render it open to empirical work, it is useful to think of it in terms of entitlements, claims and correlative duties. *Entitlements* refer to formal or statutory rights, while *claims* refer to informal processes of requesting services and resources between friends, family or others within their community. Correlative duties refer to the services, resources, opportunities and responsibilities claims and entitlements are paired with. The institutions involved in welfare provisioning engage in processes of *authoritative labelling*—processes of classifying people, needs and entitlements. In his 'labelling thesis' (Wood 2007) conceives of labelling as a negotiative process between those in authoritative labelling positions and those who are impacted for better or worse by prevailing labels when they attempt to draw upon entitlements or make claims on those charged with disposing of the resources and services. As such, authoritative labelling is a useful proxy when determining the fairness and accuracy of presently institutionalized labels and correlative duties.

Authoritative labelling informs "rules of entitlement." Entitlements and claims are not evenly distributed in stratified societies and as such one's position (for example, gender, caste, and class) and the rules of entitlement concurrent with one's social position(s) over-determine one's access to resources and opportunities. *Rules of entitlement* impart one's mode of ownership and access to resources, the rules of exchange one faces in markets, and one's access to organizations and social networks and their treatment within them (Bastiaensen et al 2002). Thus the exclusion and adverse incorporation aspects of inequality are a product of both institutional processes which apply different sets of rules of entitlement to different groups of people and a related inability to effectively contest these rules and classifications (interactional structural constraints). In general, this concept points to household capabilities as being intimately connected to entitlements and to the institutions which inform who gets what resources when and how. Thus the household strategies/actions component of our SRLA includes the relationship they have with their *institutional environment that is governed by authoritative labelling and related rules of entitlement.*

The authoritative labelling and rules of entitlement currently operating in an area's institutional environment can be analyzed to determine its welfare producing capability and to reveal the specific problems and opportunities it presents for the marginalized—in other words its profiles of exclusion, inclusion, privilege and/or adverse incorporation. In the SRLA inclusion refers to a situation where we have relatively equitable access of needed livelihood resources—a situation where benchmarks (of formal organizations or networks) are actively pursued in all areas of the city or when informal organizations or social networks are open to everyone and have roughly the same rules of entitlement. Exclusion refers to a situation where some groups, areas, or individuals are denied access or there is an absence of service or resource providing organizations or social networks. Privilege refers to areas or groups favorably biased by the "strategic selectivities" (Jessop 2001) of their institutional environment in a manner that results in their livelihoods benefitting in manner that requires forms of economic, social, or cultural oppression. Finally, adverse incorporation is a situation when some groups, individuals, or places have to pay, do or risk more for less and/or there are differences in the regularity and security of access—in other words there are different rules of entitlement at play.

---

[4] Abstract role-to-role social structures, concrete actor-to actor interactive social structures, and embodied dispositional social structures (Mouzelis 2000).

While entitlements and claims are largely determined by those in the position to deliver or mediate the delivery of related services and resources, those on the receiving end can mobilize to challenge how rights and claims are presently understood and/or their corresponding correlative duties in a city's political space. Political space includes three interrelated dimensions—institutional, discursive, and agency. The institutional includes all channels from micro to macro, from public to civil society, and from formal to informal through which the households and their existing or possible allies can attempt to impact policy formulation, implementation, and evaluations. In essence, this dimension accounts for the channels through which identities are constituted (authoritative labelling) along with the entitlements and correlative duties tied to identities—in other words gradations of citizenship and rules of entitlement. The practices actors can engage in (for example lobbying, voting, direct participation, protest, forming client-patron ties) when trying to engage these channels, represents the agency side of political processes. In this approach the discursive dimension is taken to be the most powerful intermediary factor between structures and agency as this dimension largely defines one's room to manoeuvre because it defines which groups of people can make what claims and who and what is responsible for meeting those claims. For example, in situations where neoliberal ideas about free markets, reduced state spending, and globalized growth machine cities (Molotch 1976) dominate; social justice and sustainability framed claims can expect a chilly reception. In addition, in situations where politics is currently organized around recognition of ethnic or caste difference, rather than shared material need, it is more difficult to mount a cross cutting inequality focused agenda (Fraser 2000).[5]

Analyzed in relation to each other these three dimensions of political space allow for better understanding of the interrelationships that exist between institutions, agency and inequality (Hickey & du Toit 2006). However, it does not adequately address how different material conditions work to stratify both means and modes of agency expression[6] and it does not account for the dispositional effects poverty has on what one perceives as a viable option. Wood (2003) explains why the poor continue to engage in clientelist modes of resource provisioning and politics when these are commonly seen as reproductive of inequality and detrimental to both democratization and poverty alleviation. He argues that since most southern states and markets cannot or do not provide formalized rights based channels where the poor and near-poor can secure needed resources and security (of person, shelter, assets) that they must rely on informal channels which often results in depending on various patrons and those positioned between the poor and patrons (middlemen). These actors can provide access to work, shelter, protection, and variety of basic services. This situation results in the poor being enmeshed in webs of indebtedness and dependency that are antithetical to democracy and citizenship based market, state, and community relations. The poor's dependency on clientelism and the persistent threat of increased material shortfall (future uncertainty) inculcates in their habitus[7]: risk aversion, future discounting, sense of immediacy regarding resource needs, and little trust regarding the value of formal rights (Wood 2003). This sort of habitus leads them to continue to participate as clients in order to secure present levels of resources rather than to risk opting out and demanding better resources and opportunities from formal citizen, employee, or consumer based transactions.[8]

Mapping and analyzing political space requires a sensitivity to both the political economy and dispositional structures when strategically evaluating the possibilities for and barriers to successful positive recognition and redistribution policies. One way of accomplishing this is looking at people's agency in terms of exit, voice, and loyalty. All of these need to be understood in relation to the political economy and its cognitive imprint. Hirschman (1970) suggests that there are three main ways people can respond to unsatisfactory products or performance—exit, voice, and loyalty. *Exit* in the political realm refers to one's ability to opt out of a present situation that has become unsatisfactory. For example, in patron-client relations exit is possible if another patron is seen as being a viable alternative or if formal entitlements become available and sufficient. If exit is not desirable or possible then voicing concerns officially via voting, official complaint

[5] Frasier was not speaking about the political space approach, but her arguments regarding the problems politics of recognition pose for those in need of redistribution of resources and power is relevant to this discussion.

[6] See Cleaver 2007; Hickey 2005; Wood 2003 for detail discussions of how material deprivation influences agency.

[7] Socially constructed disposition, manner, tastes, and expectations (Bourdieu 1977).

[8] In sum, for Wood (2003): To be poor means *inter alia*, to be unable to control future events because others have more control over them. This is why a sense of political economy is essential to understanding the constrained choices and options facing the poor. People are poor because of others and securing any kind of future requires recruiting the support of these others, but this only comes at the price of dependency and the foreclosure of autonomy—becoming a client, in other words. This involves the acceptance of truncated ambitions of self-improvement and advancement in order to secure basic welfare. Perversely, therefore, we encounter the deliberate strategy of choosing a coping level of poverty as the social condition of securing a sustained, albeit low level livelihood (456).

channels, protest, media, or informally is the alternative. Together *voice* and *exit* are supposed to send signals that changes need to be made if a firm, organization, or association does not want to risk losing support and thus legitimacy and possibly profits. However, if *voice* is to be effective it seems that those to whom complaints or suggestions are being made must believe that those voicing concerns do in fact have the ability to exit. If *exit* is not possible or likely than *voice*'s ability to create effective demand and thus change is greatly diminished (Wood 2007). Next, comes *loyalty*, which has both positive and negative aspects. One can be loyal to someone or something because it works well for them or they can be loyal by default when *exit or voice* is not viable, effective or a recognized option. An example of loyalty by default or resignation can be made of client-patron relationships. Since the poor actively work to maintain their side of a seemingly lopsided bargain it could be argued that they are satisfied enough with the present arrangement. However, as Wood (2001) illustrates using the example of the urban poor in Bangladesh, often those who the poor access jobs, shelter, and services from belong to the same network of which monopoly rather than competition is the rule. Thus, if one decided to exit from one patron or complain too loudly they may risk their client status across the board. The position the SRLA takes is that it is necessary to look at people's agency within political space in terms of *exit, voice, and loyalty* and that these must be analyzed with reference to their material and social context.

In sum, the institutional environment is important to study because it governs access to resources and opportunity via authoritative labelling and rules of entitlement which create a heterogeneous citizenry—different groups having different quantities and qualities of claims and entitlements. These different stocks of claims and entitlements lead to situations of privilege, inclusion, exclusion and adverse incorporation and point to the significance of political space—the avenues where the marginalized and their allies can contest or negotiate present authoritative labelling practices and correlative duties. The SRLA will analyze the institutional dimension using the concepts of authoritative labelling and rules of entitlement. It will also map political space to strategically evaluate the possibilities for negotiating identifications and correlative, services, resources and rules of entitlement across the institutional environment which intermediates between supply and demand. Both the IMD and the SRLA could provide useful and actionable content for a SII.

SII

Because there is no one-model-fits-all SII toolkit, we draw upon the concept of "the installed base" from information infrastructure theory as an entry point to the proposed study. Past research on SIIs shows the importance of recognizing the power of existing material (both human, technical and institutional) to cultivate SII development from the bottom-up as opposed to constructing it from the top-down (Georgiadou et al, 2005). A young SII should be considered as an evolving enabling and constraining, shared, and heterogeneous *installed base* (Hanseth, Lyytinen, 2004; Hanseth, Monteiro, 1998). The concept implies that SIIs always already exist in one form or another and that the existing elements of an infrastructure influence future development. New parts are integrated into an existing installed base through extension of the latter or replacement of existing parts. In this way the installed based evolves creating inertia (self-enforcement with the effects of path-dependence, lock-in, and possible inefficiencies) (Hanseth & Monteiro, 1998), but also offering opportunities for further development and "cultivation." The existence and importance of the installed base further problematize top-down approaches that dominate in India (Pfeffer et al, 2008).

In order for the heterogeneous elements of an installed base to become linked (horizontally and vertically) in a SII, standards are required (Hanseth & Lyytinen, 2004). The heterogeneity of the different elements of the installed base makes the process of setting useful and acceptable standards difficult. For analytical purposes we will distinguish three levels of heterogeneity that need to be addressed in SII cultivation. First, information is heterogeneous in terms of its form, content and purpose. Secondly, the contexts in which information is created and used can differ greatly. Thirdly, there is heterogeneity in the perceptions and meanings of spatial information and information related to poverty and urban deprivations.[9]

[9] The author conducted semi-structured interviews with city and state bureaucrats, as well as academics in the two cities. In some cases the meetings included detailed demonstrations of Geographic Information Systems (GIS) and e-governance related projects currently underway. The present discussion is also based on the author's field observation notes from offices and waiting areas in government buildings, and ad-hoc conversations with local practitioners.

Physical forms of information vary within and across organizations depending on the technologies used and purposes for its creation. For example, in one urban study site in southern India much information is handled in paper form. An Urban Development Authority (UDA) engineer stated that much of the work at the office is handled via paper files, and most digital mapping is outsourced to private consultants. On the other hand, birth and death certification is being digitized, and collected on networked databases in both cities. The city is also part of a GIS pilot project to map parcel property data with socio-economic attributes. This creates digital files of parcel boundaries, and related socio-economic data in digital form at the parcel scale. Software packages also vary. Engineers in the Municipal Corporation (MC) and City's Division of the Slum Clearance Board (SCB) use mainly AutoCAD for mapping and graphical design. Other information is digitized and stored using in-house developed software in the local language. Importantly, information created and shared in the form of narratives and "stored" in various individuals plays a large role.

A second level of heterogeneity is differences in organizational functions, objectives, and practices. These influence the type of information, the means by which it is created, and sharing practices. The SCB collects socio-economic data mainly for the purpose of slum declaration by the state. Declared slums are then mapped using AutoCAD software for visualization to support the internal work. UDA is in the process of creating new long-term planning documents, including plans for future land use. The information necessary for the preparation of these documents and mapping of the information is outsourced to private consultants, who then send already analyzed information in the form of maps and charts to UDA. Primary socio-economic information by parcel for the city is being collected in a GIS pilot project at the Municipal Corporation, which in turn provides information parallel to legacy data stored in the older tax assessment databases. Here the city's mandate is participation in the pilot project in order to make parcel information accessible online. While some of this collected socio-economic information is the same, the purposes for collection, analysis, and visualization are different. As one official stated "I know, it's all the same, but for different purposes." Different purposes and mandates require and produce heterogeneous primary and secondary information.

Where information moves between contexts, it also changes meaning. This is true not only for the movement of information between organizations, but even within departments. A higher ranking official at SCB, for example, viewed the declared slums' map mainly as a visual aid for outsiders, who wish to see the location of slums in the city. Engineers working at SCB, on the other hand, stated that they use the map for internal work themselves. Here, the same map has different meanings to different practitioners within the same office. Information changes as it travels. Poore and Chrisman (2006) write that "today it is counterproductive to employ the metaphor of information as passively flowing through a conduit" (p. 520). Instead, it is transformed and reworked by its recipients according to their work practices, responsibilities and interests. In a SII the "recipient transforming and reworking" the information can be a table or software. For example, digitizing survey information may lead to changes in language and length of each category, for example, because of restrictions in column heading width in the software. Again, the information is changed – this time by the "rules" of the software.

Thirdly, heterogeneity exists in the perceptions of the nature of spatial information. Here it is important to recognize differences in the meta-context. There are differences in the perceptions of different actors regarding what constitutes spatial information and its meaning as well as what constitutes poverty and urban deprivation data and the meanings attached. While many think of spatial information mainly in terms of GIS generated files, digital and paper maps, and remotely sensed images, there are other forms of spatial information that play an important role in daily work practices in municipal government. One of these is "tacit place knowledge" of people working at the ground-level. Much spatial information is communicated via narratives, and lists of places play an important role in work practices. Thus, while difficult to incorporate in conventional maps, this information cannot be ignored by the researchers as the project continues. In general, spatial information is information that is geo-referenced. The AutoCAD maps produced by municipal corporation and SCB, however, are not geo-referenced. Here, we have the "conventional" maps that are usually thought of as "spatial information," but they – strictly speaking – do not adhere to the above definition. For sharing and use of information in different contexts these issues are problematic. The map is meaningful only in its entirety (slum locations with roads and block boundaries, for example) in one specific context, but not necessarily as individual datasets in other contexts.

An additional layer of complexity is related to the perception of poverty and "poor areas" in the city. There is a BSUP (Basic Services to the Urban Poor) survey currently underway in one of the study sites. The main thrust of the program is the "integrated development of slums through projects for providing shelter, basic services and other related civic amenities" (Gov. of India, JNNURM – Guidelines for Basic Services to the Urban Poor, 3). Baud et al (2008), however, shows that the urban poor do not necessarily live in slums, and that wards with high slum population are not necessarily the most deprived. Therefore, not only do perceptions of what constitutes spatial information vary, but also perceptions of the criteria used to generate spatial information about poverty (in the Indian BSUP example) or multi-dimensional urban deprivation (in Baud et al's 2007 research agenda).

In order to foster the sharing of spatial information and its use to tackle multiple urban deprivation, we need to understand better the relationship between spatial information's form and content, the micro- and macro organizational contexts in which it is created and used, and the changes in information form, content, and meaning as it travels between contexts and actors who make up the installed base. However, these heterogeneous components can be difficult to capture especially ones that are normally not reflected upon. To capture the heterogeneities in the existing arrangements, and to "unearth" the connections between spatial information, actors, perceptions and contexts, we will conduct a longitudinal ethnographic study that focuses on the flows of information and surrounding work practices. With a focus on information artifacts (maps, survey forms, lists, official documents) and the practices by which they are created, moved, and used we hope to unearth the sources and flows of information of use to social justice inclined practitioners, planners, and researchers. A focus on the "boring things" (Star, 2002), and the day-to-day practices, allows us to better understand these "clashes and differences in meanings" (Star, 2002). In other words through description and analysis of the heterogeneous elements and their connections we hope to uncover both the constraints as well as the potentialities within the installed base for an inequality tracking and tackling SII to emerge.

CONCLUSION

This paper discussed the contributions SII can make to tackling urban inequalities. Regarding the conceptualisation of urban deprivations, a relational approach is necessary to include both demand side and supply side perspectives as well as the institutional environment and political space which intermediates between them. The SRLA will offer dynamic profiles of inclusion, exclusion and adverse incorporation to unpack the "snapshot" map provided by the IMD. Our analysis of the installed base will give insights regarding the construction, sharing, and use of spatial information related to urban deprivations and will provide insights into how an inequality tracking and tackling SII can be cultivated from the bottom up in our research cities in India.

Bibliography

Aanestad, M., Eric Monteiro, et al. (2007). "Information Infrastructures and Public Goods: Analytical and Practical Implications for SDI." Information Technology for Development 13 (1): 7-25.

Bastiaensen, J., De Herdt,T, Vassen, J (2002). "Poverty, Institutions and Interventions." *Institute of Dev Policy and Management Discussion Paper* **2002 - 6**.

Baud, I. S. A., N. Sridharan, et al. (2008). "Mapping urban poverty for local governance in Indian mega-city; the case of Dehli." Urban Studies 45(7): 1385-1412.

Baud, I.S.A., et al (2007) NWO-WOTRO Integrated Programme – Final Application.

Baud, I.S.A., K. Pfeffer, N. Sridharan, N. Nainan (2006) "Matching knowledge to urban governance: mapping deprivations in three Indian mega-cities," Conference UvA on Urban Segregation 6-8 July 2006.

Bourdieu, Pierre (1977) *Outline of a Theory of Practice*, Cambridge: Cambridge University Press.

Braa, J., O. Hanseth, et al. (2007). "Developing Health Information Systems in Developing Countries: The Flexible Standards Strategy." MIS Quarterly 31(2): 381-402.

Burra, S., S. Patel and T. Kerr (2003) Community-designed, built and managed toilet blocks in Indian cities, Environment and Urbanization 15(2), 11-32.

Cleaver, F. (2005). "The inequality of social capital and the reproduction of chronic poverty." World Development 33(6): 893-906.

Cleaver, F. (2007). "Understanding Agency in Collective Action." Journal of Human Development **8**(2): 223-244.

Craglia, M. (2006). "Introduction to the International Journal of Spatial Data Infrastructures Research." International Journal of Spatial Data Infrastructures Research 1: 1-13.

De, S. and A. Sen (2004) The Complex Nature of e-Government Projects: A Case Study of Bhoomi, an Initiative in Karnataka, India, Proceedings of EGOV (3rd International Conference on Electronic Government, Zaragoza, Spain, Aug 30 – Sep 3, 2004, 556-557.

Department for International Development (DFID) (2001) *Sustainable Livelihoods Guidance Sheets*. UK: DFID Available at: http://www.livelihoods.org/info/info_guidancesheets.html#1.

Douglass, M. (2000) Mega-urban Regions and World City Formation: Globalisation, the Economic Crisis and Urban Policy Issues in Pacific Asia, Urban Studies 37(12), 2315-2335.

Ferguson, C, Moser, C, and Norton, A (2007) Claiming Rights. In Moser, C (ed) *Reducing global poverty : the case for asset accumulation.* Washington DC: Brookings Institute Press.

Fraser, Nancy (2000) Rethinking Recognition. *New Left Review* 3 May/June.

Georgiadou, Y., Puri, S.K., S. Sahay (2005) Towards a potential research agenda to guide the implementation of Spatial Data Infrastructures – A case study from India, International Journal of Geographical Information Science 19, 1113-1130.

Green, M & Hulme, D (2005) "From Correlates and Characteristics to Causes: Thinking about Poverty from a Chronic Poverty Perspective," World Development. 33 (6), 867-879.

Hanseth, O. and E. Monteiro. (1998). "Understanding Information Infrastructure." Retrieved 2. July, 2008, from http://heim.ifi.uio.no/~oleha/Publications/bok.html.

Hanseth, O. and K. Lyytinen (2004). "Theorizing about the Design of Information Infrastructures: Design Kernel Theory and Principles." Working Papers on Information Systems. Sprouts. Retrieved August, 2008, from http://sprouts.aisnet.org/4-12.

Harriss, John (2006) Bringing Politics Back In Poverty Analysis: Why Understanding Social Relations Matters More For Policy On Chronic Poverty Than Measures CPRC Working Paper 77.

Harvey, D (1989) "From Managerialism to Entrepreneurialism: The Transformation in Urban Governance in Late Capitalism," *Geografiska Annaler* 71 B: 3-17.

Harvey, D (1995) "Cities or Urbanization," *City* ½ 38-61.

Henninger, N. and M. Snel (2002) Where are the Poor? Experiences with the Development and Use of Poverty Maps (WRI, Washington; UNEP/GRID-Arendal, Norway).

Hickey, S. (2005). "The politics of staying poor: exploring the political space for poverty reduction in Uganda." *World Development* **33**(6): 995-1009.

Hickey, Sam & du Toit, Andries (2006) Adverse incorporation, social exclusion and chronic poverty *CPRC Working Paper* 81.

Houtzager, P. *et al.* (2002). Rights, representation and the poor: Comparisons across Latin America and India. *LSE Working Paper, 02-31*. London: London School of Economics

Hoyt, L., Khosla, R. and C. Canepa (2005) Leaves, Pebbles, and chalk: Building a Public Participation GIS in New Delhi, India, Journal of Urban Technology 12, 1-19.

Jessop, B (2001) Institutional Returns and the Strategic-Relational Approach *Environment and Planning A* 33 (7) 1213 – 1235.

McNay (2004) Agency and Experience: Gender as a Lived Social Relation. Sociological Review 52 (1) 175-190.

Mitlin, D & Satterthwaite, D (2004) Empowering Squatter Citizen: Local Government, Civil Society and Urban Poverty Reduction. pp. 313. London: Earthscan Publications.

Molotch, H (1976) "The City as a Growth Machine: Toward a Political Economy of Place" *American Journal of Sociology* 82(2): 309-332.

Montgomery, M.R., et al. (Eds.) (2004) *Cities Transformed: Demographic Change and Its Implications in the Developing World*. London: Earthscan Publications.

Moser, C (1998) "The asset vulnerability framework: reassessing urban poverty reduction strategies," *World Development* 26(1): 1-19.

Mouzelis, N (2000) The Subjectivist-Objectivist Divide: Against Transcendence. *Sociology* 34(4) 741-762.

Onsrud, H. J. (2007). Introduction. Research and Theory in advancing Spatial Data Infrastructure Concepts. H. Onsrud. Redlands, CA, ESRI Press: 1-6.

Pfeffer, K, Baud, I.S.A, Martinez-Martin, J Sridharan, N (2008) The role of Spatial Information Infrastructure in addressing urban deprivations in Indian cities. Conference Paper: N-AEURUS.

Poore, B. S. and N. R. Chrisman (2006). "Order from Noise: Toward a Social Theory of Geographic Information." Annals of the Association of American Geographers 96(3): 508-523.

Rajabifard, A., Binns, A., Masser, D and I. Williamson (2006) The role sub-national government and the private sector in future spatial data infrastructures, International Journal of Geographical Information Science 20(7), 727-741.

Rakodi, C (2001) Ürban Governance and Poverty—Addressing Needs, Asserting Claims," International Planning Studies (6)4: 343-356.

Rakodi, C., Lloyd-Jones, T. (Eds.) (2002) *Urban Livelihoods, a People-centered Approach to Reducing Poverty*. London: Earthscan Publications.

Rolland, K. H. and E. Monteiro (2002). "Balancing the Local and the global in infrastructural information systems." The Information Society 18(2): 87-100.

Star, S. L. and K. Ruhleder (1996). "Steps toward an Ecology of Infrastructure: Design and Access for Large Information Spaces." Information Systems Research 7(1): 1111-134.

Star, Susan Leigh (2002). "Infrastructure and ethnographic practice." Scandinavian Journal of Information Systems 14(2): 107-122.

Turkstra, J., Amemiya, N. and J. Murgia (2003) Local spatial data infrastructure, Trujillo-Peru, Habitat International 27, 669-682.

Wacquant, L.J.D (2008) *Urban Outcasts: A Comparative Sociology of Advanced Marginality.* Cambridge: Polity Press.

Williamson, I. P., A. Rajabfard, et al. (2006). "Challenges and Issues for SDI Development." International Journal of Spatial Data Infrastructures Research 1: 24-35.

Wood, G. (2001). Prisoners and escapees: improving the institutional responsibility square in Bangladesh. **20:** 221-237.

Wood G.D. (2003) 'Staying Secure, Staying Poor: The "Faustian Bargain" ' *World Development* 31 (3) 455-471.

Wood, G (2007) Labels, Welfare Regimes and Intermediation: Contesting Formal Power WeD Working Paper 29, University of Bath.

Accelerating adoption and use of sustainability tools and metrics: the role of change initiators

Dr Emilia van Egmond[1], Dr Francis Edum-Fotwe[2], Prof. Happy Ratna Santosa[3]

1 – Eindhoven University of Technology, Netherlands

2 – Loughborough University, UK

3 – Institut Teknologi Sepuluh Nopember, Indonesia

Research provides evidence of instances where the people who initiate and influence change within construction are not necessarily formally designated leaders, but informal leaders. Informal leaders typically reflect the characteristics of change initiators or opinion leaders who can influence the behaviour or attitude of other people (their followers) to adopt the behaviour or attitude of the opinion leader. The significance of the role that opinion leaders play in the construction project environment stems from their potential to act as catalysts for improvement, agents of change, or the advocates for the adoption of sustainability assessment tools. The ability to identify the attributes of such informal leaders can therefore help construction organisations in achieving a better alignment in the roles they assign to project staff. This paper presents a study that explores the concept of the opinion leader to form the basis for a research to identify which actors in the construction process exhibit the most influence on the diffusion of technology solutions.

Keywords: construction, diffusion, leadership, project, sustainability, team

1. Introduction

The primary question of who instigates and influences change or the adoption of new solutions in construction often identifies prime leaders such as the client or architect as the source of such change. This is because their position within a project organisation naturally places on them the responsibility of providing leadership, as well as fostering improvement and innovation. However, organisation research provides evidence of many instances where the actors who initiate and influence change within construction are not necessarily the prime leaders, but *informal leaders*. Informal leaders typically reflect the characteristics of *opinion leaders* who can influence the behaviour or attitude of people (their followers) to adopt the behaviour or attitude of the opinion leader (Egmond and Vries, 2002; Egmond, 2006). The significance of the role that such opinion leaders play in the construction project environment stems from their potential to act as catalysts for improvement, agents of change, or the advocates for the adoption of new technology or operations (Valente and Davis, 1999). The ability to identify the attributes of such informal leaders can therefore help construction organisations in achieving a better alignment in the roles they assign to project staff. More significantly, it can help identify key individuals within construction who can spearhead the wider uptake of sustainability solutions, such as the application of various assessment tools such as BREEAM (BRE, 2007). This paper presents a study that explores the concept of the opinion leader to form the basis for a research to identify which actors in the construction process exhibit the most influence on the diffusion of technology solutions. The investigation established three principal personality attributes that characterise opinion leaders. The attributes are employed to develop an evaluation tool which is applied to assess the opinion leader characteristics of individuals in a selection of construction organisations. The study showed that while there are instances of *unconscious alignment* between the formal and informal roles, there were also cases of misalignments.

2. Construction and Sustainability Assessment

The construction industry is a traditional sector and compared to other sectors has a longer cycle for the uptake any new solution. For example, many construction organisations have electronic methods of communication, but the industry still predominantly relies on the relatively inefficient method of *hard copy* for information storage and verifiable communication (Gidado and Nichols, 2002). The transition from hardcopy to electronic options presents a good example for considering how the role of a change initiator can catalyse the process of adoption for any change solution. The role such initiators play goes to the heart of the take up of the current sustainability agenda, and particularly so for the adoption assessment tools used in appraising the level sustainable attainment for new developments. Within construction, it is typical to expect large companies to drive change and initiate new developments within the industry. They are the ones that possess the necessary resources to support the adoption of new solutions, such as financial resources, human capital and ICT capabilities (Bolte et al., 2005). For example the implementation of a fully fledged approach to assessing the sustainability of develop projects involves a multi-faceted process that calls for both technical and organisational aspects to be addressed. It has been argued by several writers that the lack of attention to the organisational aspects appears to be the dominant feature in most poor implementation of new ventures (Löfgren, 2005; Björk, 2003; Stephenson and Blaza, 2001; Laage-Hellman and Gadde, 1996). Attending to the social and organisational aspects of the take-up for any tools developed to support the implementation of sustainability is therefore essential to 'winning' the transition to full sustainability appraisal for development projects in construction.

3. Construction and Change Initiators

Over the last five decades, different scholars have explored the influences which *change initiators* or *opinion leaders* exert on their *followers*. It appears that individuals are highly influenced by others, mainly by people with whom they have a high personal contact (Coleman et al., 1957). A number of different approaches have been used to identify the characteristics of such opinion leaders, and which, makes the role they play possible within a social network. The different approaches use a procedure in which different individuals are required to *nominate* influential persons or the procedure relies on use *self-reflection* (Corey, 1971; Darden and Reynolds, 1972; Katz, 1961). For example;

- Individuals select themselves to be a peer leader;
- All members are invited to nominate opinion leaders;
- Program staff or project teams select the leaders.

For all the different approaches that rely on nomination often the individual with the most nominations is identified as the opinion leader (Valente and Davis, 1999). On the other hand, the approach of self-reflection was first used by Lazarsfeld (1944) and uses two simple questions for self-diagnosis:

- (Q1) have you recently tried to convince anyone of your personal ideas (for example political views) and,
- (2) has anyone recently asked you for your advice on an important decision (for example a political or social question).

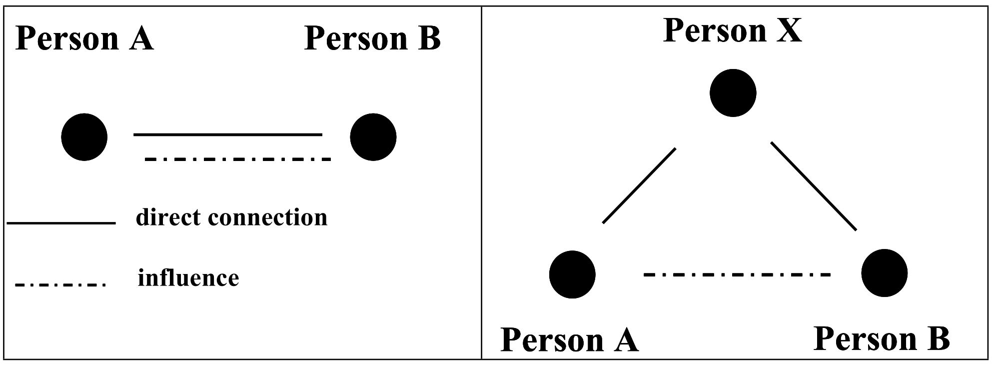
These two questions have been developed into an opinion leadership-scale by Childers (1986) and can be crudely applied to differentiate between change leaders and followers by a process described as diffusion.

3.1. What is Diffusion?

Rogers (1995) has described *diffusion* has as "the process by which an innovation is communicated through certain channels over time among the members of a social system". According to this definition, diffusion can be described in four elements: the innovation, communication channels, time and a social system. Stimulating people to adopt innovations is a difficult process. Although every innovation has a different pattern of diffusion, most are very similar. In construction, the adoption of new solutions is often driven by the client, who eventually pays for the project. However, any clear benefits and advantages derived from implementing new solutions would spur other organisations in the same competitive group to explore and exploit similar solutions. As such different types of followers or adopters exist in the sector. The nature of these adopters will be addressed in more detail in the next sub-section of this paper.

3.2. Types of Adopters

The different types of adopters or followers associated with innovation can be categorised by their *time* of adoption. Rogers (1995) proposed the adopters fall into five categories: Innovators, early adopters, early majority, late majority and laggards. The innovators comprise 2.5% of the total number of adopters and are the first individuals who adopt an innovation; they are described as being venturesome. Innovators are very eager to try new products or ideas and because of this they have to cope with a high degree of uncertainty. Early adopters are the next 13.5%, they are respected by their environment and thus more integrated with others. Early adopters decrease the uncertainty for others and are most often seen as opinion leaders. The early majority is described as being deliberate and comprises 34% of the total number of adopters. They adopt only if others do, so they adopt when early adopters do. The late majority (34%) is very sceptical about innovations. They will only adopt if others have adopted and they really have to. The last to adopt are the laggards (16%) who are very traditional, they will only adopt if there is no other way. The early adopters are usually described as having a role as opinion leaders, therefore they influence others within society to adopt as well. However, it is not only early adopters who can be opinion leaders, especially within teams. Within a team, an opinion leader usually is one of the first to adopt, but this does not mean he is an early adopter (or an innovator). However, an opinion leader is more innovative then his colleagues and might even be a laggard within society (Gann, 2000). Adopters facilitate the wider diffusion of innovation or change which Ryan and Gross (1943) argue occurs though social network or structural equivalence as illustrated in Figure 1.



a. cohesion (social network) b. structural equivalence

Figure 1. Diffusion mechanisms

3.3. Diffusion Theories and Construction Industry

Harkola and Geve (1995) argued that the diffusion of innovations within the construction industry needed a new and different approach. They tested the influence of cohesion and structural equivalence within a Japanese firm and found a significant relationship based on cohesion during the 'middle phase' of diffusion, and virtually no relation after that time. The influence of structural equivalence was focused on imitation and reference groups; 'people act as they believe people in their position should act' but 'it seems that members … came to different conclusions' (Harkola and Geve, 1995). The findings of Harkola and Geve are supported by the study of Larsen and Ballal (2005). They indicate that cohesion and structural equivalence are both important during the beginning and middle stages of the diffusion process.

4. The Research Model

This investigation that underpins this paper uses the results of prior research to develop an instrument aimed at identifying characteristics which separates opinion leaders from their followers. These characteristics are used to develop a research instrument to identify the opinion leader. The model illustrated in Figure 2 will be used as a starting-point. This theoretical model uses found characteristics to identify the opinion leader within a social network.

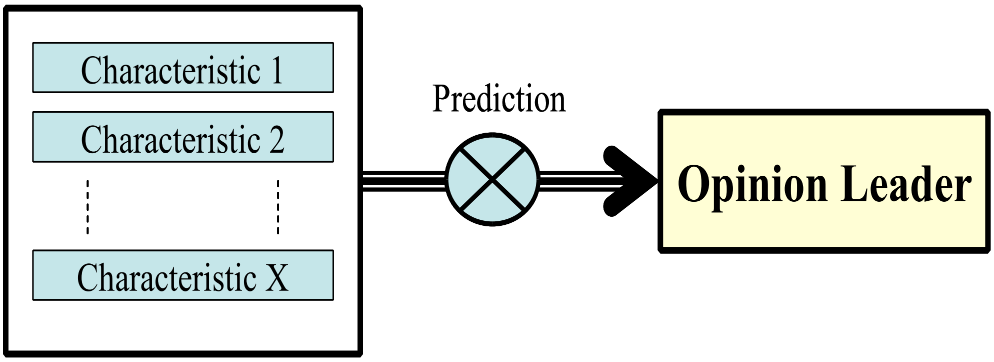


Figure 2 Theoretical model of research instrument

The study addresses the key objective by exploring the following two sub-questions:

- Which characteristics have been identified as characteristics for opinion leaders in prior research?
- Which systematic categorization of these characteristics can be made in order for them to be usable in identifying the opinion leader?

Figure 3 presents a quadrant that groups together various attributes of opinion leaders identified from literature. The category 'degree of involvement' is considered to have a positive relationship with opinion leadership, which leads to the inference that opinion leaders are more involved (with the topic of interest) then non leaders.

Degree of involvement	Personality characteristics
Involvement Level of interest Amount of information Accuracy of information Cosmopolitism Mass media exposure (printed mass media) Discussion	Individuality Self-confidence Exhibitionism Gregariousness Participation Narcissism
Degree of risk taking	**Position in- and outside the social system**
Risk preference Innovativeness Venturesomeness	Professional group membership Voluntary association membership Structural holes

Figure 3 OL characteristics

In the category 'personality characteristics', different characteristics are included, of which some have a positive relation with opinion leaders, while others have a negative relation. Opinion leaders also reflect a higher degree of risk taking as represented by the fourth category 'degree of risk taking'. The last category illustrates the importance of an opinion leader's position within and without the social system. It indicates that opinion leaders are expected to have an exceptional position in the system, because they form a bridge between social systems (those who know, and those who do not). In addition, there is a further category of 'demographic characteristics' reflects the *topic of interest* and the *social context.* Since both factors were uniform for all the respondents, this category was excluded from the research instrument. .

5. Results and Analysis

This section analyses the different characteristics that have been identified as characteristics for opinion leaders and systematically categorized the characteristics that can be used for the identification of the opinion leader. With these findings the theoretical model illustrated in Figure 2 can be populated with the appropriate variables.

The aim of the research was to identify characteristics which determine the opinion leader in the use of new solutions within a construction team or organisational unit. A total of 19 characteristics were found to be significantly related to opinion leadership, according to literature.

The 19 characteristics were classified into four different categories: *degree of involvement*, *general personality characteristics*, *degree of risk taking* and *bridging position*. For every category a characteristic is selected which was used to identify the opinion leader. The characteristics were respectively: involvement, individuality, risk taking. It was established from the data obtained that there was a strong correlation between the characteristics of individual personality and bridging position. Data from a respondent group of 79 engineers was used to develop an instrument and explore the degree to which opinion leader traits was reflected in respondents. Figure 4 presents a sample of the results from the analysis illustrating how the respondents were classified.

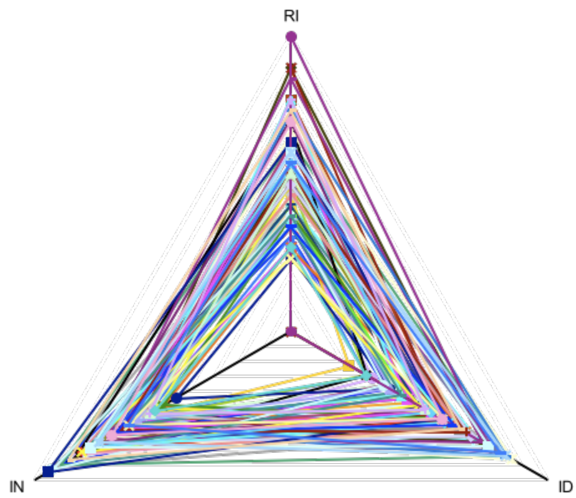


Figure 4. Plot of the OL orientation of respondent group

The results of the questionnaire and the results of the opinion leadership scale were analysed. The analysis indicated that all the characteristics were consistent and reliable, the characteristic of involvement or bridging, presented the strongest evidence as a predictor for opinion leadership. This contradicts the findings in literature, which might lead to the conclusion that risk taking as well as individuality are not a good predictor identifying the opinion leader within construction team. Further details of the instrument that was developed is available in Mortel (2007)

6. Implication for Use of Sustainability Tools

The proposed research instrument is a new solution that could be used to identify opinion leaders within a team and particularly, who should be formally assigned the role of promoting the adoption of sustainability solutions. Its strength lies in the fact that it does not ask direct questions about the influence individuals have (or receive) and thus, does not make the respondents aware of the existence of opinion leaders. Furthermore, the instrument can be used to scan a team in a relatively short period of time this is because of the short length of the questionnaire and the amount of individuals that is interviewed.

The main shortcoming of the research instrument is the fact that it needs to be tested widely to ensure that its scales are reasonably calibrated to provide reliable classification suitable for the construction sector and also address the area of sustainability. The test results of the questionnaire show that the independent scales are reliable, however, the combination of the three scales is less reliable. This provides an indication that there might still be significant correlation between the three categories adopted to classify opinion leaders or change initiators. Although different studies show that all three characterises are positively related to opinion leadership, the test results were not able to confirm this and raises questions on currently held views on who is best placed to initiate change in construction.

7. Conclusions and Recommendations

This is an explorative research towards a research instrument to identify opinion leaders. This instrument should be tested and improved in further research. The validity and reliability of the research instrument are not tested, although the questionnaire is tested for the reliability of the different scales. Based on literature, the questionnaire should be useful to predict opinion leadership. However, the current evidence of this prediction is still under investigation and further development. Different studies show that involvement, risk taking and individuality are related to opinion leadership. Further studies employing larger data sets could help to establish whether internal correlations have an influence on the three factors for predicting who should lead in initiating change within construction. For an agenda such as sustainability, this is crucial as it could reduce the time cycle for a wider adoption of any current and future solution and tools.

8. References

Björk, B.-C., (2003). Electronic Doument Management in Construction - Research issues and Results. (Z. Turk, Ed.) *ITCon*, 8, 105-117.

Bolte, G., Molenaar, T., and Waal, M. D., (2005). *ICT in de bouw*. Rotterdam: SBR.

BRE, 2007. *Building Research Establishment Environmental Assessment Method (BREEAM)*, BRE, UK

Childers, T. L., (1986). Assessment of the Psychometric Properties of an Opinion Leadership Scale. *Journal of Marketing Research*, 23 (2), 184-188.

Coleman, J., Katz, E., and Menzel, H. (1957). The Diffusion of an Innovation among Physicians. S*ociometry*, 20, 253-270.

Corey, L. G., (1971). People Who Claim to Be Opinion Leaders: Identifying Their Characteristics by Self-Report. *Journal of Marketing*, 35, 48-53.

Darden, W. R. and Reynolds, F. D., (1972). Predicting Opinion Leadership for Men's Apparel Fashions. *Journal of Marketing Research*, 9 (3), 324-328.

Gann, D. M. (2000). *Building Innovation - Complex Constructs in a Changing World.* London: Thomas Telford Publishing.

Gidado, K. and Nichols, M., (2002). The Current State of Use of Electronic Document Management System by UK Architectural Practice. *International Conference on Decision Making in Urban and Civil Engineering*. London.

Harkola, J. and Greve, A., (1995). Diffusion of Technology: Cohesion or Structural Equivalence? *Academy of Management Journal: Best Paper Proceedings*, 422-26.

Katz, E., (1961). The Social Itinerary of Technical Change: Two Studies on Diffusion. In W. Schramm (Ed.), *Studies on Innovation and of Communication to the Public*. Stanford, CA: Stanford University.

Laage-Hellman, J. and Gadde, L.-E., (1996). Information technology and the efficiency of materials supply. *European Journal of Purchasing & Supply Management*, 2 (4), 221-228.

Larsen, G. D. and Ballal, T. M., (2005). The diffusion of Innovations within a UKCI context: an explanatory framework. *Construction Management and Economies*, 23, 81-91.

Lazarsfeld, P. F., Berelson, B. and Gaudet, H., (1944). *The people's choice: how the voter makes up his mind in a presidential campaign*. New York: Columbia University Press .

Löfgren, A., (2005). Socio-technical management of collaborative mobile computing in construction. *CIB W78 Conference*. Dresden, Germany.

Rogers, E. M., (1995). *Diffusion of Innovations*. New York: The Free Press.

Ryan, B. and Gross, N. C., (1943). The diffusion of hybrid corn in two Iowa communities. *Rural Sociology*, 8, 15–24.

Stephenson, P. and Blaza, S., (2001). Implementing technological change in construction organisations. *Proceedings of the IT in Construction in Africa Conference*. Mpumalunga, South Afr.

Valente, T. W. and Davis, R. L., (1999). Accelerating the Diffusion of Innovations Using Opinion Leaders. *Annals of the American Academy of Political and Social Science*, 566, 55-67.

Mortel, S.F. Van de, (2007). *Stimulating the use of ICT in construction: Towards a research instrument to identify opinion leaders*. Faculty of Technology Management, Tue, Eindhoven.

Egmond, E. van and Vries S. K. de, (2002) Sustainable construction industry development through international transfer of innovative technologies. In: Conference Proceedings, CIB W107 International Conference - Creating a sustainable construction industry in developing countries, 11-13 November 2002, Stellenbosch, South Africa

Egmond, E. v. (2006) Innovation and Technology Diffusion in Construction by means of Strategic Niche Management. In: R. Pietroforte, E.de Angelis, editors, *Construction in the XXI century: Local and global challenges*, Proceedings of the Joint International Symposium of CIB Working Commissions W55/W65/W86, Rome.

Public participation in Malaysian district local planning system

Assoc. Prof. Dasimah Bt Omar

Universiti Teknologi Mara, Malaysia

This paper explores the practice of public participation in local planning system in Malaysia. The research focused on the Sabak Bernam District Local Plan (SBDLP) 2002-2015 which was gazetted in June 2007. Public participation is compulsory in the process of preparing Development Plans (Structure Plans or Local Plans). The impact of the new requirement of Town and Country Planning Act 1976, named Town and Country Planning (Amendment) Act 2001, is that the number of public participation activities has increased in preparing District Local Plans. Sabak Bernam District Local Plan is the first District Local Plan prepared under the provision of Section 12a, Town and Country Planning (Amendment) Act 2001. The public participation programmes were held at every stage of SBDLP preparation process including a workshop and exhibition at the early stage of study; followed by a workshop after the technical report was prepared; another workshop after draft proposal was prepared; and an exhibition after the draft proposal had been amended. It shows the government has put an effort to increase the role of stakeholders in preparing development plans. The main approach of public participation adopted in this country is exhibition and hearing.

The research was carried out at two different stages. The first research was by collecting feedback from the participants of public exhibitions and workshops. A total of 51 respondents were interviewed using survey questionnaire. Secondary information was collected from the related agencies. The analysis involved analysing feedback from the public who participated in the workshop after draft proposal of Sabak Bernam District Local Plan 2002-2015 was prepared. Feedbacks of respondents have been studied to identify the effectiveness of the overall programmes and the effectiveness of each main aspect or element of public participation. It was found that series of workshops were a more effective method of public participation for development plan as compared to one exhibition after draft proposal or plan has been completed.

The second research was based on the SBDLP Public Participation and Objection Report prepared by the Department of Town and Country Planning Headquarters. Beside the content analysis of the report, an in-depth interview was carried out involving the 10 stakeholders who attended the Objection Committee Meeting. The research found that there was lack of participation by the stakeholder with only 526 or 0.46 percent of the district total population. Only 29 or 59 percent of the issues, objection and proposal raised by the public has been considered in the implementation of the Sabak Bernam District Local Plan. Therefore, there is a need to address the issues and the challenges of public participation in Malaysian district local planning system.

Keywords: Town and Country Planning Act 1976, development plans, district local plan, public participation, public participation and objection report

Introduction

The aim of participatory activities is to let people involve in the decision making process. Public Participation is the process by which the public concerns, needs and values are incorporated into governmental and corporate decision making. It is a two way communication and interaction, with the overall aim of better decisions that are supported by the public (Creighton 2005: 7).

The Chapter 28 of Agenda 21 notes the pivotal role of Local Government, recognised the need for local leadership and stressed the participation of local governments and their stakeholders in the development of local solutions. The Local Agenda 21 planning framework was developed by the International Council for Local Environmental Initiatives as a tool to assist local governments in the development of plans and strategies. The framework is essentially a multi-stakeholder action planning process. It frames planning elements (partnerships, evaluation, community-based issue analysis, action planning, implementation and monitoring) but does not ascribe particular outcomes. Creighton (2005) states that public participation is an important and often mandatory part of environmental decision making. Currently, hundreds of governments globally including Malaysia are implementing the development of Local Agenda 21 plans.

Background of Public Participation Studies in General

The effectiveness of these public participation methods is arguable. Katherine (2008) in her review paper commented that 'in a book written for scholars, activists, and government leaders—but equally useful for practitioners—13 authors critically examine successes and failures in public participation'. As mentioned by Ortolano (1984), the public hearing is the most rigid way of public participation. The public must know the details of the planning issues, scopes, constraints and detail information. 'Public participation creates a new direct link between the public and the decision makers in the bureaucracy. It is a way of ensuring genuine interaction and a way of reassuring the public that all viewpoints are being considered Creighton (2005:7). Officially, U. S. Environmental Protection Agency (2002), uses the term "public participation" to denote the activities where permitting agencies and permittees encourage public input and feedback, conduct a dialogue with the public, provide access to decision-makers, assimilate public viewpoints and preferences, and demonstrate that those viewpoints and preferences have been considered by the decision-makers. As stated by Lyn Carson (2008) it is getting government to evaluate its commitments and ensuring that they keep their public participation promises.

Public Participation and Planning in Malaysia

Currently, in Malaysia public participation is accepted as a crucial stage in planning especially the plan preparation stage. This is to ensure that the people are involved and have the right to be informed in planning their areas. In Malaysian planning system public participation is a vital factor for the achievement of sustainable development. The Town and Country Planning Act 1976 (Act 172) Section 9 stated that when preparing a state structure plan, the report of survey which contains key findings of the study area must be publicised. This is to give an opportunity for the stakeholders to make representations. After completion the draft structure plan should be made available for public inspection. Notification for the public is through local newspapers. The public are given is not less than one month from the date of notice and can be extended upon request from the stakeholders. As for the local plans and special area plan the same procedure applies as stated in Section 13 of the Act 172. There is an additional provision introduced with the amendment of Act 172 in 2001 (Act A1129), which requires publicity has to be given to a proposed plan even before its preparation. Section 12 A stated that publicity should include the objectives, the purpose and matters to be included in the proposed plan. a local plan or special area plan. The amendment is very vital because it allows public participation from the early stage of plan preparation. The need for public participation in planning is sufficiently provided for by the Act 172 and its subsequent amendments.

The Federal Department of Town and Country Planning continuously improve the approach, coverage and techniques used in public participation. A Guideline on Publicity and Public Participation has been prepared providing a check list of activities conducted for development plan preparation. Under the Ninth Malaysia Plan (2006-2010) the Focus Group Discussion technique is practiced in the preparation of development plans. In Malaysia the Focus Group Discussion technique is very helpful especially at the local level due to lack of documented data (Mohd Fadhil 2008).

Planning Process in Malaysia

After independence in 1957 the Malaysian administrative system is divided into three levels: federal government, state government and local government. The powers of each level of government are enshrined in the Constitution and Parliament Acts.

Planning matters are in the concurrent list where both the federal and state governments are responsible for. At federal level, the Federal Department of Town and Country Planning which is under the Ministry of Housing and Local Government is responsible for formulating and administering all national policies relating to town and country planning. At state level, The State Department of Town and Country Planning is an advisory body to the state governments in Peninsular Malaysia while Sabah and Sarawak are practicing under different acts. At the local level, local authorities are responsible for executing town and country planning function as prescribed in the local plan. In Malaysia land is a state matter. Therefore land use planning is a state issue and the Federal government is to take on a supervisory role with the overall land use planning activity. The land use planning system introduced by the 1976 Act express the authorities intentions to initiate, encourage and control physical, economic, environmental and social changes in a particular area.

The first draft of the Town and Country Planning Ordinance of Malaya was prepared in 1966 and revised in 1972 to incorporate the need for a National Master Plan, the creation of several levels of planning authorities and the bringing of public participation into the planning process. In 1976, the Malaysian Parliament enacted the Town and Country Planning Act 1976 [Act 172] aiming at introducing a uniform system of law and policy for town and country planning in Peninsular Malaysia. Among the important features of TCP Act 1976 was the introduction of two-tier Development Plan system: Structure Plan and Local Plan; a system of Development Control; establishment of State Planning Committee and the setting up of Appeals Board. The 1976 Act was amended in 1995 through the Town and Country Planning (Amendment) Act 1995 [Act A933] which emphasised environmental management in planning, such as conservation of topographical features and trees.

In 2001 the Act was again amended through the Town and Country Planning (Amendment) Act 2001 [Act A1129] which seeks to balance the power between the Federal and State governments in matters related to town and country planning. The Act introduces the establishment of the National Physical Planning Council, Regional Planning Committee and National Physical Plan. The latest amendment was in September 2007 through the Town and Country Planning (Amendment) Act 2007 [Act A1312] which is to confer the executive authority on the Federal Government over certain matters in relation to the control and regulation of town and country planning in Peninsular Malaysia. The Town and Country Planning Act 1976 (Act 172) and its subsequent amendments stated the provision of public participation in Sections 9 (1, 2 and 3), 12 A, 13, 14 and 15. This ensures that public participation is mandatory in the formulation of development plans in the country.

The Town and Country Planning Act 1976 (Act 172)

This Act is to ensure uniformity of law and policy for proper control and regulation of town and country planning; it is also to confer executive authority of the Federation over certain matters related to town and country planning in Peninsular Malaysia. At the Federal level the Act provides for the establishment of the National Planning Council chaired by the Prime Minister and is responsible for town planning policies of the country. The Director General of Town and Country Planning Department is the Secretary of the Council. The National Physical Plan has been approved by Cabinet on 20th April 2005 and National Physical Planning Council on 26th April 2005. The functions of the council as provided under section 2A of Act 172 are to:

a. promote town and country planning as an effective and efficient instrument for improvement of the physical environment and towards the achievement of sustainable development in the country;
b. advise Federal Government or the government of any State, on matters relating to the town and country planning required under the Act; and
c. perform any other functions conferred upon the National Physical Planning Council under this Act.

The Act provides the State Authority overall responsibility to plan on the use and development of the land in the State. It delegates its planning responsibilities through a State Planning Committee with the Chief Minister as The Chairman and its Secretariat, the State Town and Country Planning Department. It will also monitor progress of the State Structure Plan which is enacted under the Town and Country Planning Act 1976 (Act 172) as a tool for proper planning and development of the state. The Structure Plan is a written statement that explains strategic policies and actions concerning the land use development in town and rural areas, including steps to:

a. improve physical environment.

b. improve communications and traffic management.

c. improve socio-economic levels, encourage economic growth.

d. enhance rural planning.

e. facilitate sustainable development.

The State Authority also provides local planning authorities the responsibility to plan, control and conserve land and buildings in their localities. Every local authority is the local planning authority for its area as stated by the Act. Local Plan is prepared for identified area within the Local Authority territory. It serves as a detailed plan that interprets policies and suggestions that are contained in the Structure Plan. It shows a large-scale layout plan for a territory, supported with written statement to explain policies and further details concerning the development. It will play a vital role in both guiding long term decisions about the future of the district and day to day development control decisions about individual planning and other applications.

The Local Plan will also:

- allocate specific sites for development;
- set out criteria by which planning applications are assessed; and
- address a wide range of community and environmental issues.

The role of Local Government is in the provisions of the Local Government Act, 1976 (Act 171). The Act relates to their own operations, forming strong local partnerships, helping communities understand sustainability, encouraging debate on sustainability issues and leading the LA21 planning process.

Public Participation in the Preparation of Local Plan under Act 172

Section 12A of Town and Country Planning Act 1976 (Act 172), stated that before commencing the preparation of a local plan the local planning authority shall take such steps as will in its opinion secure that:

a. publicity is given in its area to the draft local plan that will be prepared, its objection and the purpose for its preparation, and matters that the local planning authority proposes to include in the plan;

b. persons who may be expected to desire an opportunity of making representations to the local planning authority in respect of those matters are made aware that they are entitled to, and are given, an opportunity of doing so.

Under the Section 13 of the Act, when the local planning authority has prepared a draft local plan, it shall, before adopting a draft local plan, make copies of the draft local plan available for inspection at its office and at such other places as it may determine for not less than 4 weeks. Beside, objections to or representations in respect of the draft local plan may be made to the local planning authority.

Under the Section 14, Act 172, for the purpose of considering objections to and representations in respect of a draft local plan, the local planning authority may cause a local inquiry or other hearing to be held by a committee of three persons appointed by the State Planning Committee. According to Section 15, Act 172, after considering the objections or representations, the local planning authority shall submit the draft local plan or the draft local plan as modified so as to take account of the objections or representations or of any matters arising there from to the State Planning

Public Participation in Sabak Bernam District Local Plan 2002-2015

Sabak Bernam District Local Plan is the first Local Plan prepared under the provision of Section 12a, Town and Country Planning (Amendment) Act 2001. Both researches were to identify the effectiveness of public participation programmes for Sabak Bernam District Local Plan. Section 12A does not limit the period for public to make representations. Sabak Bernam District Council has organised workshops and exhibitions for public to participate in the Sabak Bernam District Local Plan making process; starting from early stage until end of the plan preparation.

The public participation programmes were held at every stage of plan preparation process, which start with (Dasimah and Oliver Ling 2007):

a. A workshop and exhibition at the early stage of study; followed by
b. A workshop after the technical report was prepared;
c. A workshop after draft proposal was prepared; and
d. An exhibition after the draft proposal had been amended.

Objectives

The objectives to be achieved in both studies were to:

i. analyse the needs and effectiveness of the public participation methods currently used in the development plan preparation process, in moving towards a more sustainable development practice.

ii. evaluate information from the Public participation and Objection Report and Sabak Bernam District Local Plan 2002-2015

iii. identify the appropriate methods, approaches or actions for more effective public participation for the study area, in moving towards a more sustainable development practice.

Research Methodology

The research was carried out at two different stages. The first research was carried out in 2004 by collecting feedback from the participants of public exhibitions and workshops (Dasimah and Oliver 2004). A total of 51 respondents were interviewed using survey questionnaire. Secondary information was collected from the related agencies. The analysis involved analysing feedback from the people who participated in the workshop after draft proposal of Sabak Bernam District Local Plan 2002-2015 was prepared. Feedbacks of respondents studied to identify the effectiveness of the overall programmes and the effectiveness of each main aspect or element of public participation.

In 2008 the second research was completed based on the Public Participation and Objection Report prepared by the Federal Department of Town and Country Planning (Mohd Izad 2008). Beside the content analysis of the report, an in-depth interview was carried out involving 10 stakeholders who attended the Objection Committee Meeting. As stated in the Act 172, every objection, issue and proposal should be considered by the local plan. The primary data were collected through interview sessions with five professionals and 10 public participants. The professionals were committee members involved in the public participation programmes. They are the Project Manager, Core Team members, planners from the Selangor State Town and Country Planning Department and Sabak Bernam Local Authority. The public interview focused on 10 participants who attended the Public Hearing and Objection Meeting. These people were traced from the filing record with permission from the Federal Department of Town and Country Planning, Peninsular Malaysia. The names of persons who made objections and proposals either through objection form or forum are recorded in the Public Participation and Objection Report.

Analysis and Findings

The analysis and findings of both researches are explained separately. It starts with the first research and followed by the second research.

Analysis and findings of the first research titled "The Effectiveness of Public Participation Programme in the Development Plan Preparation Process, from the Perspective of Sustainable Development Planning"

From the survey of the first research, it was found that, the highest aspects of concern for most of the respondents were infrastructure and public facilities development, future economic development, and environmental issues and quality. In general, majority of respondents (69 percent) felt that the effectiveness of the public participation programme was moderate while 31 percent stated that it was very effective. Series of workshops were a more effective method of public participation for development plan as compared to one exhibition after draft proposal or plan has been completed.

The effectiveness of the programme also includes the use of banners and effective presentations and the information was clearly understood by all respondents. Only six percent of the respondents said that the banners and presentations were not effective. Besides that, the public participation programme managed to deliver enough relevant information to participants, used effective methods of publicity and effective methods for participants to give ideas, opinions or comments. The methods used in the public participation programme included written comments and oral discussion during the workshop. Besides that, the programme had successfully made the 88 percent of participants believe that, the government would consider their opinions seriously in the process of preparing the plan. Most of them (94 percent) felt that they had equal rights and chances in getting information and participating.

Other factors contributed to the effectiveness of the public participation programme were:

a. The limitation was clearly explained by the study team during the workshop. As a result, the participants received better understanding regarding the scope of the discussion.

b. Majority of the respondents received response from the government on their decision, as well as the reasons for accepting or rejecting the public opinions. That was done through the two-way communication during the workshop.
c. Participants were guided by the study consultants or professional planners effectively during the workshop.

However, the public participation programme also faced few weaknesses, as shown below:

a. 50 percent of respondents felt that, the programme failed to deliver enough information on the future development of the area. The public were expecting more details or comprehensive information on the future development for their areas.
b. The development constraints were not presented clearly, lack of detailed information and not specific for the public to understand as stated by 56 percent of the respondents.

The public participation programme failed to deliver enough relevant information to the majority of the participants. Besides that, the method used for giving ideas, opinions or comments by participants also was less effective. The programme was not successful in delivering enough information on the future development of the area during the public exhibition. There were one third (33 percent) of the respondents who felt that, the method used (in written form only) was not effective.
The research also found that organising series of workshops was an effective method of public participation for development plan. This is because an effective and successful public participation programme should allow members of the community to have an active voice in the process and to have access to important information.

Analysis and findings of the second research titled "The Effectiveness of Public Participation in Local Plan Preparation Based on the Public Participation and Objection Report, Case Study: Sabak Bernam District Local Plan".

The second research found that there was lack of participation with only 526 or 0.46 percent of the district total population of 113,245 (year 2000). Only 29 or 59 percent of the issues, objections and proposals raised by the public been considered in the implementation of the Sabak Bernam District Local Plan. Therefore, there is a need to address the issues and the challenges of public participation in Malaysian district local planning system.

As mentioned earlier the secondary data and information required for analysis came from two main sources namely the Public Participation and Objection Report and the gazzetted District Local Plan. Both reports compliment to each other and valuable to public and citizens. There were three variables considered in the content analysis:

i. has been considered

ii. not consideration

iii. unrelated to the scope of study

The types of issues, objections and proposals listed in the Public Participation and Objection Report and actions taken by the Sabak Bernam District Local Plan as shown in Table 1.

The table shows that from the list of 49 issues, objections and proposals stated in the Public Participation and Objection Report, only 29 or 59 percent were considered in the Sabak Bernam District Local Plan 2002-2015. The list shows that there were seven issues on public facilities and also on traffic and transport management raised by the public. However, it was found that for public facilities only three issues were considered, three were not related to the scope of study while another was con been considered. From the list, it shows that five issues related to industry and also traffic and transportation management were among the highest number been considered by the District Local Plan. There were four issues on recreations and landscape and also infrastructure and utilities. This is followed by issues on town center and urban design and public facilities. There were eight issues categorised as unrelated while another eight were not being considered by the District Local Plan.

Table 1: Content Analysis of the Public Participation and Objection Report and the Sabak Bernam District Local Plan 2002-2015 (Mohd Izad 2008)

No.	**Public Participation and Objection Report**		**Sabak Bernam District Local Plan 2002-2015**			
	Sectors	**Issues and Objection**	**Has been considered**	**Not considered**	**Unrelated**	**Total**
1.	Macro Perspective and Border Development	1	1	-	-	1
2.	Land use and Physical	2	-	2	-	2
3.	Town Center and Urban Design	3	3	-	-	3
4.	Recreations and Landscape	4	2	-	2	4

5.	Housing	2	1	1	-	2
6.	Public Facilities	7	3	1	3	7
7.	Rural and Settlement Development	1	1	-	-	1
8.	Demography	1	1	-	-	1
9.	Trade	2	1	1	-	2
10.	Industry	6	5	1	-	6
11.	Agriculture, Fisheries and Forestry	2	2	-	-	2
12.	Tourism and Natural Resources	1	1	-	-	1
13.	Traffic and Transportation Management	7	5	-	1	7
14.	Infrastructure and Utilities	4	1	2	1	4
15.	Management and Implementation	1	1	-	-	1
16.	Exhibitions Management	1	-	-	1	1
17.	Outside the scope of study – Planning Permission	4	-	-	4	4
	Total	49	29	8	8	49

Based on feedback from four professional respondents, they were satisfied with the participation by 526 people of Sabak Bernam. However, they suggested that there is a need to introduce some new elements in the public participation programme to encourage more participants. The respondents found that participants were not clearly about District Local Plan, their roles and the responsible agencies. This was shown by the 16 percent of objections, comments and proposals highlighted were not related to the scope of study. Thus, this will influence the implementation of local plan, which was based on Public Participant and Objection Report. They also agreed to the participants' feedback that publicity and notification was not channeled properly to the public. Generally, the respondents were satisfied with public participation programme and they were fully involved in preparation of the Public Participant and Objection Report.

The professionals interviewed mentioned that about 60 percent of issues highlighted were considered for implementation by the local plan. Majority of them also agreed with the role of Public Hearing Committee members. Public Hearing Committee comprising representatives of professional bodies and practicing professionals, to hear and consider public objections. However, one respondent did not agree with the role played by the committee. This was due to the inactive committee members who just listen and did not respond to the issues highlighted.

Based on feedback from 10 public participants, they need a proper channel to receive information related to decision made by committees regarding their issues. As representatives of Sabak Bernam community, participants recommended for a more effective notifications for this study area. They recommended for a simple briefing session organised for community's committee at early stage of study. They suggested for more efforts by responsible government agencies which will affect the effectiveness of public participation programme.

Recommendation and Conclusion

The series of workshops and public exhibitions should be organised from the beginning of the plan preparation to the final stage of the process, which include:

a. Workshop at the early stage (before the start of the plan preparation);
b. Workshop and public exhibition after the technical report has been prepared; and
c. Workshop and public exhibition after the draft proposal has been prepared.

These workshops should be attended by all stakeholders including the officers from the planning authority, planners, non government organisations and general public. Workshop at the early stage should aim at getting the public informed about the purpose, scope, limitation and the importance of the plan making. Besides that, the workshop should give opportunity to the stakeholders to give their opinions and views before the preparation of the plan.

Besides, workshops and public exhibitions should be held at strategic locations. The criteria of good location are:

a. high accessibility via public transport system and roads,
b. public focus area or community centre, and
c. ample and suitable space for various activities/purposes.

The local planning authority is the proper agency to act as an organiser for the public participation programme as agreed by majority of respondents. However, the organiser of the public participation programme should consider better actions to increase the public trust. There are other ways to improve the effectiveness of the public participation programme. This include the decision making process, whereby the government especially the town planners should always provide the best mechanism for the more effective public participation in the local planning process. The whole community should work hand-in-hand to take the challenge for a sustainable growth of development. A holistic approach in decision making bringing together the social, economic and physical environmental issues to ensure that the environment is developed to benefit the present community and the future generation. It means providing for effective participation at all levels of strategic planning, providing clear, comprehensive and effective community involvement in local decision-making and providing a robust regulatory framework on which the public and local government can rely with some certainty.

The Public Participation and Objection Report should be considered as one of the guidance in the implementation of district local plan. The content is very important as an evidence of the community representation to fulfill their right in the local plan. However, the research found that this report is not effective due to lack of quality data. Generally, the recommendations aimed to increase the effectiveness of public participation in district local plan preparation. The effectiveness of public participation programme will produce more comprehensive district local plan in Malaysia.

References

"Agenda 21 and the 1992 Earth Summit Agreements", (on line) http://habitat.igc.org. (accessed in year 2008).

Conor, Desmond M. (1997) "Constructive Citizen Participation: How to Prevent and Resolve Public Controversy". Canada, Connor Development Services Ltd.

Conor, Desmond M. (1999) "Model Approaches for Public Participation". Canada, Connor Development Services Ltd.

Creighton, L.J. (2005) "The Public Participation Handbook"**.** New York**,** Wiley.

Dasimah Omar and Oliver Ling Hoon Leh (2004) "The Effectiveness of Public Participation Programme in the Development Plan Preparation Process, from the Perspective of Sustainable Development Planning". (unpublished research) Universiti Teknologi MARA Malaysia.

Dasimah Omar and Oliver Ling Hoon Leh (2007) "Effectiveness of Public Participation Programme: A Feedback from Participants (Sabak Bernam District Local Plan and Kuala Lumpur Structure Plan*)*". Planning Malaysia 5: 1-16, Malaysian Institute of Planners.

Government of Malaysia (2007) "Town and Country Planning Act 1976 (Act 172) (Amendment) (Act 1312)". Federal Department of Town and Country Planning, Kuala Lumpur.

Hunt D. and Johnson C. (1995) "Environmental Management Systems – Principle and Practice". London, McGraw Hill Book Company.

Katherine J. Hall (2008) "Communication and Public Participation in Environmental Decision Making, The International Journal of Public Participation, Vol. 2No. 2, December 2008.

Lyn Carson (2008) "The IAP2 Spectrum: Larry Susskind in Conversation with IAP2 Members, The International Journal of Public Participation, Vol. 2 No. 2, December 2008.

Malaysia Law (2002) "Town and Country Planning Act 1976 (Act 172)". Kuala Lumpur, International Law Book Services.

Mohd Fadhil Hj Mohd Khir (2008) "Planning for Sustainability Harmonious Cities". Celebration of World Planning and World Habitat Day, PICC Putrajaya.

Mohd Izad bin Yahya (2008) "The Effectiveness of Public Participation in Local Plan Preparation Based on the Public Participation and Objection Report, Case Study: District Local Plan of Sabak Bernam, Selangor Darul Ehsan", (unpublished research), Universiti Teknologi MARA Malaysia.

Ortolano L. (1984) "Environmental Planning and Decision Making". Canada, Stanford University.

Peoples' participation in sustainable community development

Haniyeh Houdsony, Kourosh Ali Rezaee Parto
Tehran City Renovation Organization, Iran

In recent decades, the theory of Sustainable Development has been introduced to several strands of science. This theory and its special view to communities (Sustainable Community Development) as the cell of urban life, demonstrates the solution to urban problems by highlighting the meaning of neighborhoods in cities. In the local scale, it is essential to use a collaborative process of development, which is based on the active participation of local people as social capital.

In this way, the perception of local residents of a collaborative process is what makes this process successful or otherwise.

This article identifies the perception of local residents towards the collaborative process and its positive and negative aspects. This is done using the 'Deep Interview' and 'Focus Group Discussion' techniques, deployed within the Jolfa Mahalla community, as a sample urban neighborhood in Tehran, capital of Iran with a rich historical background and strong social networks.

This paper aims to argue that the lack of a participatory culture between people and local residents can result in the breakdown of relationship and communication between them, but more importantly, the absence of local urban spaces in neighborhoods further strengthens this problem. Thus, making suitable local spaces encourages people to participate in local projects.

Keywords: deep interview, people participation, resident's perception, social capital, sustainable community development

1. Introduction

During last decades, "Sustainable Development" theory becomes one of the most practical views to solve universal problems. However this model is quite appropriate in urban issues, its implementation causes serious problems in local scale.

Because of a lack of local and regional characteristics in the plans, implementation of this model in the world caused new problems in cities. Therefore parallel with this theory and even before it, there was a vision which believed that solving problems must occur in the local scale.

With this reality in sustainable development, an urban area can not strive with out the resources of its environs; moreover, it would not continue its life without paying attention to its internal elements which are urban cells or "Neighborhoods". Due to this vision, the planning of safe, convenient and attractive neighborhoods is seen as an essential part of sustainable development programs in the world. Flanagan, like many other theorists, believes that solving urban problems happens through internal potentials in neighborhoods such as local groups and communities, which act as social capital and which have a special place and usage in mega cities to keep and develop social interactions in neighborhoods. (Flanagan, 1993) These two theories result in a new vision called "Sustainable Community Development". This vision indicates that urban neighborhoods have great social and cultural potentials and it is only through their revitalization as the major field of local residents' social life can sustainable community development occur. Some movements, such as the WHO Healthy Cities movement, have since the 1980s, provided a model for inclusive, collaborative working at the levels of both neighborhood and municipality.

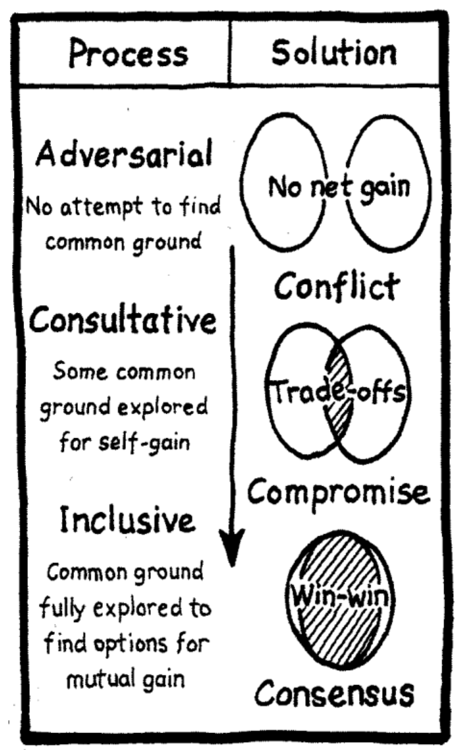


Figure1. **Build on common ground** (Barton, 2003, p: 42)

How to make it possible for people to be involved in shaping and managing their environment is what the community design movement has been exploring over the past few decades. (Sanoff, 2000)

Therefore, it is essential that a participatory process defines through the development process of an area. Due to the fact that the major element in a participatory process is the participation of the local groups and communities, it is vital that all changes and plans in an area occur with reference to the local people's perceptions of a collaborative process.

As a result, the method of Deep Interview as a qualitative method has been used. Using this method, it is possible to understand the local residents' visions and also the area's problems and varying priorities.

2- Basic Principle: Co-operative Sustainable Community Development

In the 1990s, Community Development, which had a long history in implementation and theory since the70s and 80s, after a short break (Banerjee, 1984, p: 283; Johnson, undated, p2) became once again, one of the most important fields in composition with sustainable development. Research indicated that the best kind of community development, both in theory and practice, is the process in which the development occurs with the active participation of local communities as social capital.

This strategy focuses on internal methods and local guidance in neighborhood planning. Sustainability objectives in neighborhoods create strong goals in neighborhood planning and design. Such guidelines can be defined such as local people's participation, stakeholder involvement, increase local autonomy, connectivity, diversity and so on.

The active involvement of all the locally relevant interests in the process of decision-making is widely recognized as essential if sustainable development is to be achieved. Thus, it is essential that the mechanisms which caused all stakeholders involved in processes will be developed. These mechanisms must be adaptable for different conditions.

The co-operative principle defines that the creation of sustainable neighborhoods depends on the active commitment of local stakeholders. Public, private and community sectors need to pursue common purposes. This co-operative principle is not about romantic community idealism; it is about co-ordination. (Barton, 2003: p 42)

Figure2. **The four partners in neighborhood planning** (Barton, 2003, p: 43)

As has been argued, the most important point in sustainable community development is the participation of local partners in neighborhood. Therefore, it is essential to get to know these groups. In figure 2, we can see the neighborhood as divided into four parts.

The planners are responsible for the spatial evolution of an area toward sustainable development. They produce the plans and policies but have little direct power of implementation, relying on the other partners. Investors and providers are the private-, public- and voluntary-sector organizations who are the main agencies of change. Local voluntary organizations include campaigning groups, service-providers and a host of social, religious and recreational clubs and associations. Certain groups may see participation in community development projects as central to their mission, but most will not. Many will have a remit and catchments much broader than any specific neighborhood. The people of the area are the users of the neighborhood – the real owners. They include all the residents, together with local business people, workers, and those dependent on local leisure/retail/education/health facilities but who live outside the area. Typically, about 10 percent of local residents are members of organized groups – so 90 percent of local residents are unrepresented except through the ballot box. Consultation processes often fail to reach (or motivate) the most vulnerable or marginalized groups. (Barton, 2003, p: 43)

The most important goal to use of these groups is establishing local governance. In this way, it is essential that first the city and neighborhood councils are elected and then, local authorities are given power.

3- Methodology

In this research, the method of collecting information is Deep Interview and Focus Group Discussion. The reason is the extensiveness and the multi-dimensionality of this subject matter. Moreover, lack of information and practical research in this field makes such an approach a necessity.

The foucus groups in this research are residents of Jolfa Mahalla and the method of selecting people is "systematic clustering."

In Deep Interview, different kinds of people have been interviewed. Some are Municipal and Cultural Center Authorities, and some are old residents. A systematic way is to ask the people who have been interviewed to suggest new interviewees. In this way, fifteen people were interviewed. The most important criteria for the selection of the interviewees was residency in the area for at least five years. For this purpose, two people who work in the Municipality of region 3 and have lived in the neighborhood for many years were interviewed and then more people were introduced by them. Moreover, some people were chosen from the cultural centre since it has a very important role in practicing people's participation.

Another method is Focus Group Discussion. A Focus Group is a discussion group that meets regularly throughout the plan-making processes. It acts as a proxy for the local people, hopefully reflecting their consensus. It may be joined by volunteering or by invitation. If possible, it should include people from diverse backgrounds within the community.

After interviews, an attempt was made to shape such focus groups.

In order to set up a focus group, a landowner, developer or regeneration partnership could do the following:

1. Hold an initial public meeting (widely advertised) to raise the key issues before the detailed development proposals have gelled or an architect been briefed;

2. Ask for people at the meeting to volunteer themselves to be involved in on-going discussions, giving their specific interests and skills;
3. From a residents' focus group (preferably without pre-selection) to meet regularly and represent the local community interests; and
4. When the plan or planning application is submitted, include a report of the focus group and public meetings, and action taken to recognize and deal with the concerns raised.

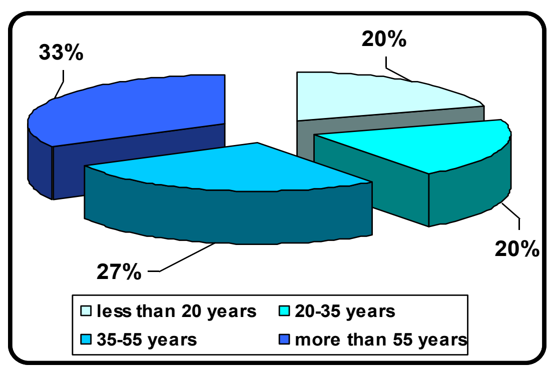
Figure3. **The location of Jolfa Mahalla and its borders**

4- Analyzing the Residents' Perception in Jolfa Mahalla

In order to analyze the local residents' perception in the neighborhood, Jolfa Mahalla is selected, which has special characteristics:

This area is located in south-east of the third zone of Tehran Municipality whose borders are Resalat Highway in the south, Hemmat Highway in the north, Haqanni Highway in the west and Shariati Main Street in the east. This area has the northern-southern street, (Jolfa Arasbaran Street) which is key to the local traffic network. Jolfa Mahalla has strong physical elements as well as spatial and social structure in its historic centre. Nevertheless, the new developments that include: the

Figure 4. **The age of Interviewees**



construction of a new highway on its borders; the construction of an Art and culture center; the building of Neshat Park and Khaje Nasir University; and the unjustifiable introduction of commercial and administrative landuse in the eastern and southern border, has all resulted in the collapse of the spatial and social structure of the neighborhood. Moreover, this has resulted in less social communication between local people and because this area has an important role in the regional traffic network, it has caused a decrease in the local participatory role of this area. Residential landuse is the majority but the Art Cultural Center has affected it's environ as special cultural landuse. Moreover, the University of KhajeNasir which covers two great city blocks and also AbasAbad Hills and Neshat regional park have a great influence on cultural and physical structure of the area.

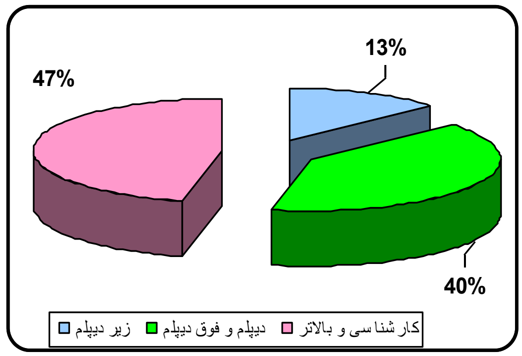


Figure5. **Level of interviewee's education**

As it is seen, in this research Deep Interview and Focus Group Discussion methods are used to comprehend the perception of people from a collaborative process. In this way, fifteen persons were interviewed.

The characteristics that were noticed in choosing people are being residents of the neighborhood for more than 5 years. For this purpose, 2 persons who work in municipality and have lived in the neighborhood for many years were interviewed and some people were introduced through them. Moreover, because of the fact that the cultural center has a main role in people's participation, some people were chosen from there. The location of interview was spread throughout the area. In general, some characteristics such as age, sex, education and other factors are taken into account in choosing people. 60 percent of interviewees were male and 40 percent were females. The reason could be that the men are more than the women in public spaces and also they were more motivated to participate in interviews. In return, the women especially in older ages, were more interested in collaborative activities in their neighborhoods. What could be deduced from the results is that the most interests in participatory activities are between the first age group (more than 55 years) and the less interests is between the group of 35-55 years. Indeed because of their business, they did not have enough time to participate in this kind of activities. The education analysis shows that the area is in a good condition which can result in a healthy perception of the participatory process.

The studies show interesting and various results about the place of interview, in that most of the interviewees in the public places are more interested in participatory processes and they are more concerned about their neighborhoods. As it was expected, the result of the research shows that the residents who had lived there longer and the people who are the owners of the buildings are more willing to participate and they are more responsible about their local matters. The results of the interviews are as below:

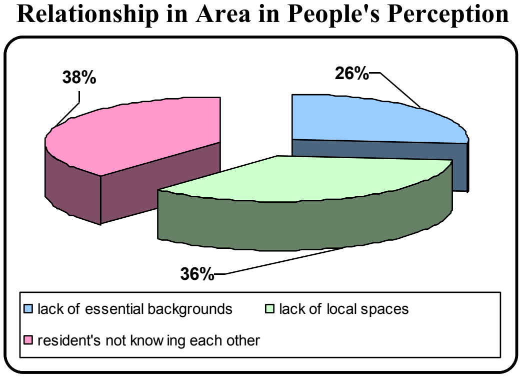
	Field	People's Perception
1	Culture	▪ The absence of culture in field of acceptance and preference of collective to personal profit ▪ Nonexistence of participatory culture among community groups ▪ Elimination of economical profit from local activities ▪ The absence of participatory culture among new generation because of not having experience specially in local scale ▪ Initiating and strengthening the relationship between local people in order to establish participation ▪ The creation of collaborative behavior among local people through local groups and communities
2	Communities and Local groups	▪ Absence of knowledge about local groups ▪ Lack of information about the essence of local groups ▪ Nonexistence of information about their activities' field ▪ Using of religious minorities such as Armenian as an potential ▪ Motivate local people to participate in local affairs ▪ Increase in neighborhood's safety through local people's supervision Essential need to motivate youngsters and middle-aged to participate ▪ Preparedness of special social groups of local people to participate and collaborate in different programs ▪ The existence of the most rate of responsibility among aged groups and old residents
3	Participation	▪ Lack of essential backgrounds for local communication ▪ To make local groups involved in planning process practically ▪ To celebrate different ceremonies in order to make people knowing each other ▪ To generally inform people in collaborative plans ▪ Community groups must be supported by Municipality as connective bridge between people and policy-makers ▪ Existence of a direct relationship between feeling belonged and social supervision of residents ▪ Existence of strong social relationship provided that good urban spaces in neighborhoods ▪ Decrease in people knowledge about each other because of increase in construction

Figure6. **The deduced results of the interviews**

Figure7. **Residents' Perception from Elements of Spatial Structure**

In figure 7, the elements which are in residents' perception of local spatial structure are seen as symbolic elements and land uses. Analyzing the results of interviews about collaborative processes show that there are three reasons for the lack of communication between residents. The first is little relationship between local people; the second is the lack of local spaces; and the third is the lack of essential backgrounds and the practice of participation in local scale.

Figure8. **The reasons of lack of Social Relationship in Area in People's Perception**



In their perception, what makes them participate in local planning and processes are the increase in their responsibility about their local matters which can be increased through using potential groups such as youngsters and women in shape of local communities and close relationship between them.

Figure 9 can be seen as a conclusion. Figure 10 shows the spatial structure of this neighborhood. This structure and its comparison with the people's perception shows that local spaces are the most influential in people's communication. Therefore, local land use and urban spaces have a very important role in social communication between people, and the lack of such spaces leads to dilution of local communication and people's participation in local affairs.

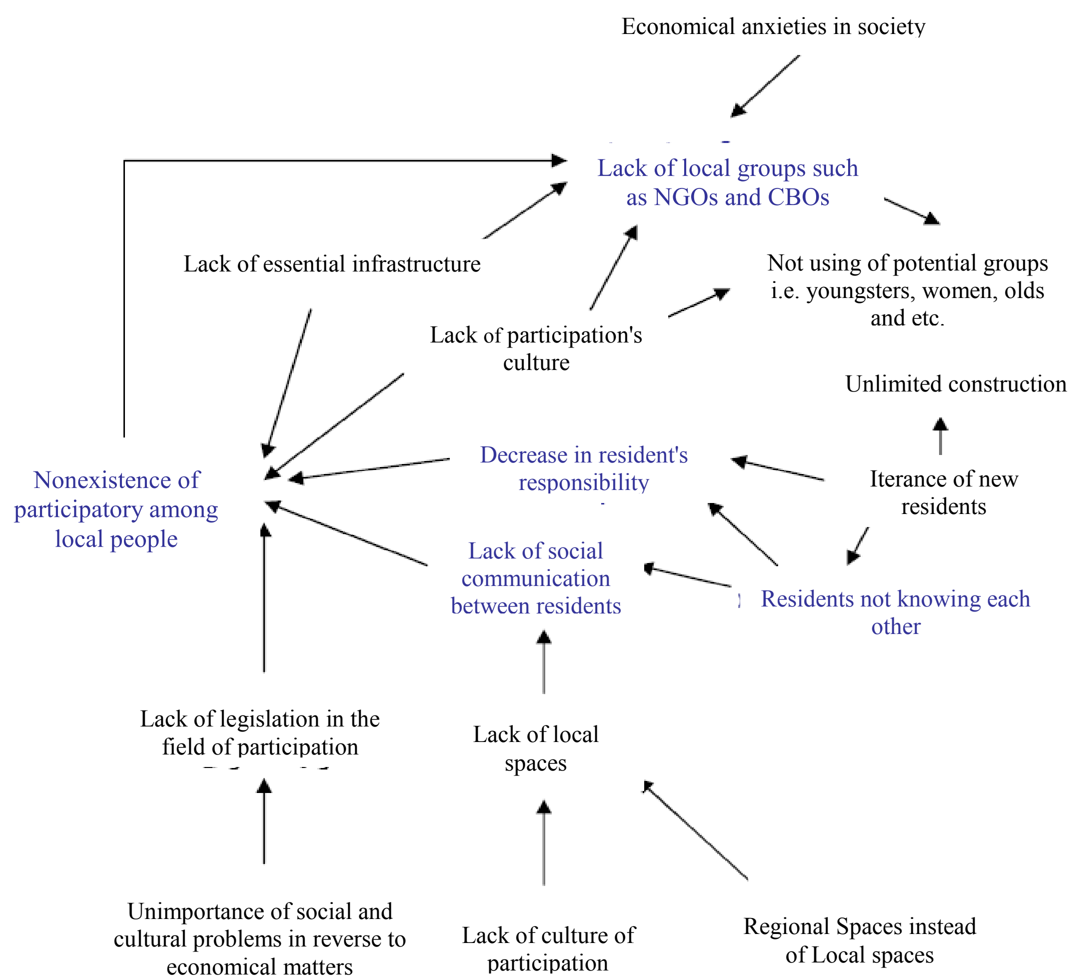


Figure9. **Analysis of People Perception's of Social Capital Problems in Jolfa Mahalla**

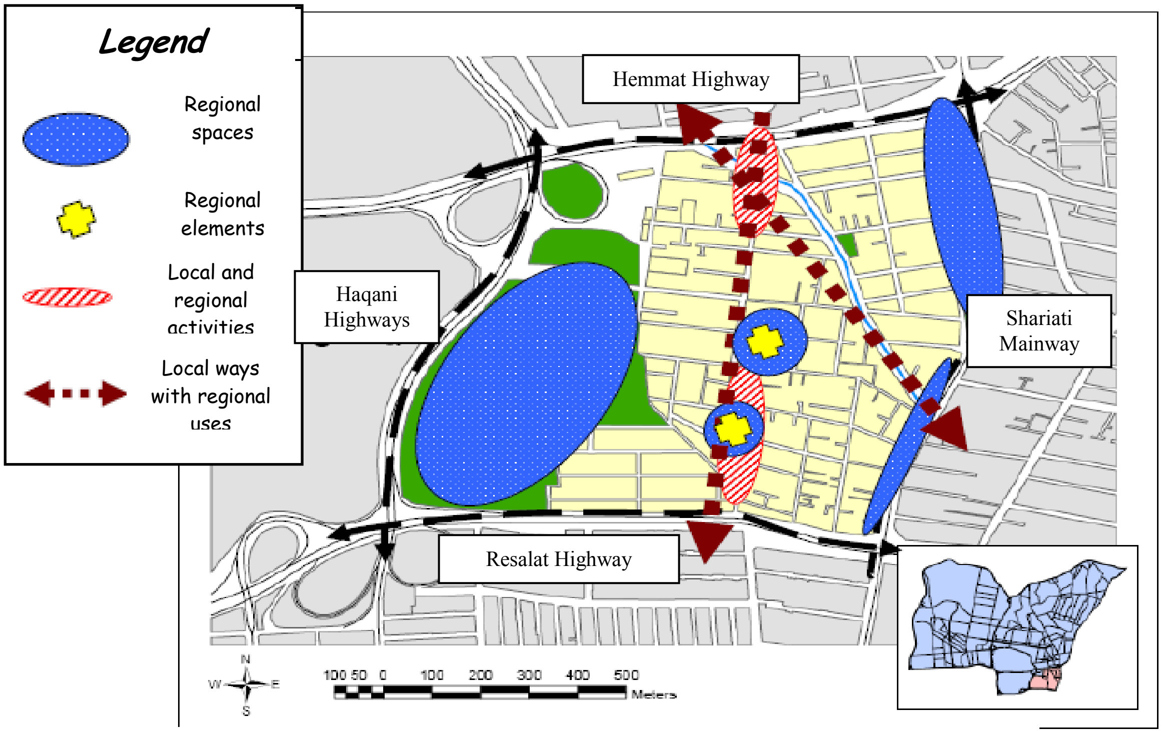


Figure10. **The relationship between Social and Spatial structure Analysis**

5. Conclusion

According to much research in the last decades, Sustainable Community Development has been theorized as a strong answer to the increasing urban and global problems.

This vision indicates that solving problems necessitates a return to the general meaning of neighborhood and community as social capital.

In this principle, a collaborative process for development has been defined in which local people's participation in a neighborhood is its chief element. It shows that the best form of community development and intervention in a neighborhood is a co-operative and participatory process in decision-making and its application. It is essential that all stakeholders including local communities and residents be involved in the proposed plans.

In this research, the local people’s perceptions were studied using the deep interview method in Jolfa Mahalla.

The results show that unlike the strong relationship between people of the past, nowadays one can see a decline in social communication and participation. It seems evident that not only the lack of participative and collaborative culture is to blame, but also the lack of local spaces which further strengthen this phenomenon. Moreover, widespread inexperience in participation and collaborative processes, is seen by the local residents as another important factor. They proposed that the activities which strengthen the sense of responsibility and local ownership between stakeholders can trigger potential-rich communities such as youth groups, women groups and others into action, leading to a strengthening of social communication between people.

Resources:

1) **An Interaction Approach to Sustainable Community Development. http://www.cas.nercerd.psu/Community/Legac/bridger_interactional.html**
2) Asgari A, (1383) **Type of visions in Sustainable Community Development,** Congress of Sustainable Community Development of the City of Tehran, Tehran.
3) Banerjee T, et al. (1984) **Beyond the Neighborhood Unit: Residential Environment and Public Policy,** Plenum Press, New York.
4) Barton H, et al. (2003) **Shaping Neighborhoods**, Spon Press, New York.
5) **Changing Values, Changing Communities: A Guide to the Development of Healthy, Sustainable Communities,** CMHC SCHL, Research & Development Highlights, and Issue 25.
6) Flanagan W (1993), **Contemporary Urban Sociology**, University Press, Cambridge.
7) Healy P (1997), **Collaborative Planning: Shaping Places in Fragmented Societies,** McMillan, England.
8) Himona R (undated), **what is community development? ,** Conference of the Community Development Group, Department of Internal Affairs.
9) Johnson R (undated), **Urban Residential Patterns: an Introductory Review,** Bell, London.
10) Kahn A (1970), **Theory and Practice of Social Planning**, New York: Russell Sage Foundation.
11) Linton G (1998), **Interagency Forum on Sustainable Communities & Regions,** White House Conference Center.
12) Mousavi Y (1382), **urban reconstruction with reference to Community Development,** The office of studies and researches of cultural department of Tehran Municipality, Tehran.

13) Rafieian M, et al. (1383), **Sustainable Community Development: Principles and History,** Congress of Sustainable Community Development of the City of Tehran, Tehran.
14) Roseland M (1998), **Sustainable Communities: Resources for Citizens and Their Governments,** New Society Publishes, Gabriola Island, BC.
15) Roseland M (2000), **Sustainable Community Development: Integrating Environmental, Economic and Social Objectives,** Community Economic Development Centre, Department of Geography, Simon Fraser University.
16) Robinson J (1980), **Community Development in the United States**, Iowa State University Press, 73-95, Iowa.
17) Sanoff H (2000), **Community Participation Methods in Design and Planning,** Jhon Wiley & Sons, Inc.
18) Sarafi M (1381), **The basis of Sustainable Development of the Megacity of Tehran**, Issue 11, pp3-9.
19) Voth D (undated)**, "Community and Community Development: Parts I to III,** University of Arkansas.
http://www.uark.edu/depts/hesweb/hdfsrs/rsoc4263/cdbook6.pdf
20) Williams K, et al. (2001) **Achieving Sustainable Urban Form,** E&FN Spon, London.

Stakeholder engagement in sustainable housing refurbishment in UK

Dr Yamuna Kaluarachchi[1], Prof. Keith Jones[2]

1 – Kingston University, UK
2 – University of Greenwich, UK

The UK government is committed to effectively implement a viable sustainable agenda in the social housing sector. To this end housing associations and local authorities are being encouraged to improve the environmental performance of their new and existing homes. Whilst much attention has been focused on new housing (e.g. the Code for Sustainable Homes) little effort has been focussed on improving the 3.9 (approx) million homes maintained and managed by the public sector (in England), which, given the low rate of new build and demolition (<1% in England), will represent approximately 70% of the public housing stock in 2050. Thus, if UK is to achieve sustainable public housing the major effort will have to focus on the existing stock. However, interpreting the sustainability agenda for an existing housing portfolio is not a straight foreword activity. In addition to finding a 'technical' solution, landlords also have to address the socio-economic issues that balance quality of expectations of tenants with the economic realities of funding social housing refurbishment. This paper will report the findings of a qualitative study (participatory approach) that examined the processes by which a large public landlord sought to develop a long-term sustainable housing strategy. Through a series of individual meetings and group workshops the research team identified: committed leadership; attitudes towards technology; social awareness; and collective understanding of the sustainability agenda as key issues that the organisation needed to address in developing a robust and defendable refurbishment strategy. The paper concludes that the challenges faced by the landlord in improving the sustainability of their existing stock are not primarily technical, but socio-economic. Further, while the economic challenges: initial capital cost; lack of funding; and pay-back periods can be overcome, if the political will exists, by fiscal measures; the social challenges: health & well-being; poverty; security; space needs; behaviour change; education; and trust; are much more complex in nature and will require a coordinated approach from all the stakeholders involved in the wider community if they are to be effectively addressed. The key challenge to public housing landlords is to develop mechanisms that can identify and interpret the complex nature of the social sustainability agenda in a way that reflects local aspirations (although the authors believe the factors will exist in all social housing communities, their relative importance is likely to vary between communities) whilst addressing Government agendas.

Keywords: public housing, stakeholder engagement, stakeholder participation, stakeholders, sustainable housing

1.0 Introduction

Stakeholders are groups or individuals who have a stake in, or expectation of a project's performance. In the case of social housing these include tenants, housing providers, managers of different sectors, developers, designers, subcontractors, suppliers, funding bodies and the community at large. Stakeholders can influence the direction and decisions of a project by retaining the current status or enforcing change. Gaining approval for a project or implementing successful change during projects is therefore largely dependent on stakeholders' attitudes, motives and expectations. These groups have expectations, which the project is under pressure to fulfil; this may not be a problem were it not for the fact that different groups of stakeholders often have conflicting expectations (Newcombe, 2003). Frequent conflicts between stakeholders revolve around long-term versus short-term objectives, cost efficiency versus need, quality versus quantity, and control versus independence. In housing, the tenant as a stakeholder has become more powerful and influential with the formation of 'Tenant Liaising Groups' and can form and shape the strategy of the project. The concept of sustainability has gained wide acceptance in policy and rhetoric and can also be viewed from different perspectives. The diversity of perspectives on sustainability poses a challenge to those developing sustainability strategies. Sustainability is an ambitious goal, which requires, among other efforts, new kinds of governance and decision-making processes involving a large variety of stakeholders (Irwin et al., 1994; Loorbach and Rotmans, 2006). Hence, understanding stakeholders has a significant role to play in the pursuit of sustainability, and achieving its goals.

The term sustainable housing is commonly understood. To some it means reduced environmental impact, to others it refers to housing that is affordable and contributes to community cohesion (Pickvance, 2009). Thus, whilst the UK government is committed to effectively implement a viable sustainable agenda in the social housing sector and the housing associations and local authorities are being encouraged to improve the environmental performance of their new (CLG 2006, CfSH) and existing homes (ECOHOMES XB), to many landlords such a narrow focus may miss the bigger issues associated with the sustainability agenda.

In 2007 there were 3.873 million homes maintained and managed by the public sector authorities in England (CLG, Housing Statistics, 2009). In the past, the environmental performance of new homes has been emphasised when, in fact, the existing stock offers the greatest opportunity for environmental improvement. Assuming a constant rate of growth in the English housing stock of 0.935% (Net growth in 2007) then 67.6% of the housing in 2050 will comprise that already built today (CLG, Housing stats 2009). Thus, when one considers the current state of English social housing, of which 29.2% is classed as non-decent [A dwelling is defined as non decent if it fails any one of the following 4 criteria; current statutory minimum, reasonable state of repair, reasonably modern facilities and services, reasonable degree of thermal comfort- CLG, Housing Green Paper 2000]; 34.% has a Energy Efficiency Rating below Band D [SAP rating of less than 55]; and where located in predominantly local authority areas, tenants were much more likely to experience serious problems relating to anti-social behaviour (e.g. litter, vandalism and graffiti) and much more likely to report serious problems related to drug use, troublesome youth, vandalism and burglary.(EHCS, 2008); the challenge facing landlords in establishing a sustainability agenda goes beyond simply reducing the impact of the house unit on the environment. This is the challenge that social housing landlords are struggling to come to terms with.

This paper presents the formulation, implementation and results of a participatory research programme undertaken in conjunction with a large urban social housing provider that was initiating a sustainable refurbishment programme.

2.0 Research Methodology – The Research Partner

The results presented in this paper form part of a wider ranging study into the management issues associated with the effective implementation of sustainable solutions in social housing refurbishment. A number of social landlords were approached by the research team and invited to join an ongoing research project investigating new processes that were needed to support sustainable housing refurbishment. The rationale for selection in the study was:

- That they possessed a substantive housing stock that contained a range of building types (single occupancy housing, multi-occupancy low rise flats, multi-occupancy high rise flats and supported [sheltered] housing units) but was not too big as to obscure over-riding issues;

- That they were about to embark on a major refurbishment programme;

- That they were willing to engage in a participatory research model in which researchers would engage with those developing the refurbishment strategy to establish the research problem(s) they were facing and develop and test solutions in a real world setting.

The organisation reported in this study was a Borough Council who had 4000 housing units accommodating 20,000 tenants. The organisation's political leadership and senior management team had a positive attitude to 'green' issues and were actively trying to promote climate change, micro-generation, and the use of renewable technology to their tenants. With backing from the leadership, officers had embarked on a 'Sustainable refurbishment programme' that incorporated the retro-fitting of innovative environmental technologies to their existing housing stock. A series of meetings, workshops; interviews; and email correspondence took place between members of the research team and employees of the participating organisation between June 2006 and January 2007.

At an initial meeting with the Director of the Housing Division, the Sustainable Development Manager and a representative of the housing team established the background to the department and the issues that they were currently addressing. Whilst the department had a number of 'green' policies and had experimented with various sustainable technologies (such as combined heat & power) on a number of housing schemes, their approach to decision making was fragmented and they recognised the need to act in a more cohesive [strategic] manner. This issue was emphasised in their desire to move away from a short term view of their developments (5 years) to a longer term view over 20 years. To support this desire the department had embarked on a 'Best Value' review of their approach to sustainability and the environment, and had recognised the need for an 'Environment Champion' to help drive the agenda forward. One of the first challenges identified for the Environment Champion was a review of occupancy behaviour in relation to their sustainable refurbishment programme. Finally, when pressed by the research team to identify the single most important issue or problem facing the department as it sought to develop its long-term strategy, communality of purpose, and in particular a shared understanding of the sustainability agenda (technological, social, environmental, economic), was identified. In order to develop a solution to this problem a workshop was proposed in which representatives from all the internal departments (or work groups within departments) within the organisation that had an input into the refurbishment decision making process would meet and consider what sustainability meant from their perspective.

3.0 Stakeholder Engagement Workshop

The workshop was held approximately 6 weeks after the initial meeting. The aim of the workshop was twofold, firstly to establish what the sustainability debate meant to each distinctive group and secondly to identify the management challenges that the housing department faced as they sought to move to a more strategic view of housing refurbishment.

Fifty participants attended a one-day workshop held away from the organisations normal place of work. In the morning a series of presentations were given by the research team. These focussed primarily on sustainable technology. Following the presentations and open question and answer session (45 minutes) was held. Whilst a few questions sought further explanations about the technologies presented, the majority focussed on what sustainability actually meant in a social housing context. In particular discussions ensued between representatives of the various departments about how and why the organisation was pursuing the sustainability agenda. In essence the debate polarised into two camps; those who believed it was the right thing to do no matter what the problems (the enthusiasts) and those who thought it was a waste of time (because they could have little impact on the bigger picture) and as such thought the organisation should do the minimum to satisfy Government (policy and legislation) requirements. This theme was picked up again in the workshops.

In the workshop, the delegates were divided into 5 groups according to the sector they worked in. Job titles/affiliations were provided by the organisation prior to the workshop. These sectors were:

- Housing Policy/ Strategy and Development (Which included the managers responsible for strategic decision-making)
- Sustainability Team (technical professionals)
- Area Managers (housing operations)
- Neighbourhood Managers (Housing officers and those working directly with tenants)
- Community Participation Team (Personnel who had direct contact with tenants)

Each workshop was facilitated by an experienced member of the research team. Each group were asked to consider/discuss three common questions (1-3) and one specific question (1 of 4-6). The questions were:

1. What factors do you think would most improve tenants' quality of life?

2. What are the environment technologies that can make a real difference in tenants' life?

3. What are the barriers in implementing these sustainable technologies in housing developments?

4. Which criteria influence the decision making process in allocating resources? (to the Policy/Strategic Development Group)

5. How do tenants' feel about incorporating environmental technologies in their home? (to the Neighbourhood Managers and Community Participation Team)

6. What improvements will provide a better service to tenants'? (to the Sustainability Team and Area Managers)

Questions 1 and 2 were designed to assess the level of agreement (or disagreement) between the perceived quality of life needs of tenants and the impact that different environmental technologies were perceived to have. Question 3 was designed to assess whether perceived barriers could be categorised as either strategic/generic or tactical/operational and if they could, whether the categorisation depended on the groups work focus (i.e. do those charged with strategic decision making only see strategic barriers and those working directly with tenants tactical barriers). Questions 4 and 5 were designed to highlight external (to the organisation) issues that were influencing decision making either directly, or through intervening variables. Question 6 was designed to examine whether internal (to the organisation) processes were inhibiting the uptake of sustainable technologies. Taken together the outputs of the workshop were expected to show the management attitude (was it cohesive or disjointed?) within the organisation's decisions making process. By understanding this it was hoped to be able to develop management systems that could accelerate the uptake of sustainable solutions into the housing refurbishment process.

The underlying theory behind the workshop was not shared with any of those who attended the workshop. Each group were presented with their 4 questions and asked to discuss each of them in turn. The role of the facilitator was to initiate the discussions but then only answer direct questions about interpretation of the question and not to participate in the ensuring discussions. The facilitator made notes of the answers that were given by the group. When discussion of each question was complete the group were asked to rank their responses in order of importance (where appropriate). The workshops lasted for 75 minutes and were followed by a general plenary session in which the facilitators reported the main findings from their group. A short discussion followed the group feedback.

4.0 Results from the workshop

The results from the workshop are shown in Table 1.

Table 1- Workshop Results

Questions	**Housing Policy/ Strategy and Development**	**Neighbourhood Managers**	**Community Participation Team**	**Sustainability Team**	**Area Managers**
1. What factors do you think would most improve tenants' quality of life?	Safer environments Money- income, jobs Value for money (cost of housing) Increased opportunities Health & wellbeing Space	[more] Money Internal / external environment Education (quality) Modernised/ user friendly (decent housing), type of accommodation Participation Employment opportunity Healthy life style	Lower fuel bills, Technology Change of behaviour Meters (monitor and feed back) Educating tenants of their impact On the environment Subsidisation on billing, Asthma reduction, Space layout-futurbility, utilisation Rubbish- consideration given to waste bin locations etc. Damp reduction- condensation Economic, ventilation condensation, of source, heat recovery	Reduction in fuel prices Safe living environment Choice- property, area Warm homes Decent homes plus Affordable housing Life time homes	Reduce Fuel poverty 10% warmer Warm, Draught-proof home, comfort
2. What are the environment technologies that can make a real difference in tenants' life?	Double glazing for existing houses (in new a standard) Insulation (for noise reduction, reduced bills, CCTV- Surveillance technology for access control etc. This depend on the type of house- for flats concierge service the input could be higher, Energy efficiency (electrical, gas, thermostats), Individual controls (educating tenants in usage)	Solar power units Cladding Alarm systems Complicated systems replaced with user friendly systems Double gazing *CHP Individual heating systems instead of communal (maintenance) recycling	What saves money? What is good for my health What is easy to operate, by tenants What is cost effective for the council/ pay back Work on estate level rather than individual houses, Easy to install Lack of risk, Recycling Consider water efficiency at maintenance/ refurb Flats- review payments of bill, Practical	Efficient heating/ hot water Insulation- dealing with building fabric Controlled ventilation- comfort (thermal) Recycling Methods- Direct, indirect Renewable Technology Questionable performance?	CHP Insulation Wind- mainly macro Tidal barrage- Thames barrier Solar thermal systems PV systems Ground heat pumps Heat exchangers (e.g.-from crematoriums) Double glazing CFTs
3. What are the barriers in implementing these sustainable technologies in housing developments?	Initial cost- value for money, long payback periods, re-organise the structure, competing priorities, Grants- availability of options and alternatives, Maintenance- staff for maintenance Lack of regulations, Planning- regulatory, politics Tenants- lack of interest, Reluctance to pay upfront	Money (installations) Service providers (expenses) Political decisions Tenants attitudes No incentives to encourage- works	Fear of change Technology costs- installation/ time scales- risk Lack of inclination Lack of skills Disruption Push/ Pull Not realising the benefits Standards-not high enough	Cost Physical Constraints Political/ legislation/ funding Social Understanding technology maintenance	Cost both to customer and council User behaviour 'Short terminism' in the business sense (e.g. PVC) Decent homes criteria / policies Lack of knowledge Both suppliers and users
4 – Group specific questions	**Which criteria influence the decision making process in allocating resources?**	**How do the tenants' feel about incorporating environment technologies?**		**What improvements will provide a better service to the tenants?**	
	(funding governs and spans all these criteria) Statutory requirements, Targets- achieving government, targets, political connotations, Tenant interest requirements, Good value for money- payback period, options, Annual budget, Speed of delivery, Lease holder tribunals	They haven't got a clue Education and incentives Legislation, encouragement, commercial incentives	Need to get the basics right first- lifts that work, no damp/ cleanliness issues Not enough trust that the system works Lack of information Lack of credibility of green issues Practical. visible, working examples needed for tenants	Efficient organisation of LBG and all of the above Change in subsidiary arrangements	Not just tenants, Information/ education, Environmental assessment of all activities, Micro grid, Biomass for fuel for fleet, Grants, Environmental 'gold' services- option, like Stirling engine (additional rent option for added technology e.g. CHP). Pooling knowledge, CHP to blocks with individual control and billing

4.1 Quality of Life

There was broad agreement that a reduction in the cost (to the tenant) of fuel required to run the home was the single most important factor that would improve the tenant's quality of life. For those who worked directly with tenants this was expressed in terms of lower fuel bills or access to [more] money [through benefits]; for those who were responsible for the quality of the housing this was expressed in terms of a reduction in fuel price or greater access to income generating activities (jobs).

For the groups who worked directly with tenants; fuel poverty, warm homes, comfort, which are the basic standards of housing seem to be the priority while more general, strategic issues seem to be the priority for the decision makers. Three groups; Teams Sustainability & Community participation and Area managers stated elimination of fuel poverty as their number one priority in improving a tenant's quality of life while the other two groups (40%) stated money, income, jobs and cost of housing as their priority.

Whilst it is dangerous to dig too deeply into the meaning of language used by workshop groups there does appear to be a difference, with those who are close to the tenant tending to use tactical/operational language (e.g. money, education) and those who were one step removed from the tenant using strategic (e.g. fuel poverty, life time homes) language. This could indicate a different focus on the issues of quality of life.

In compiling the criteria that were stated as important in improving a tenant's quality of life by various groups, it was observed that many responses were repeated by the groups but not in the same priority order. Safe living environments were sighted by three groups (60% of the sample- Policy/Strategy & Development managers, Sustainability team & Neighbourhood managers) as a second priority and increased opportunities, education, jobs were cited by two groups as a third priority (Policy/Strategy & Dev managers & Neighbourhood managers). Good quality decent homes were mentioned by four groups but at varying priority levels (Figure 1).

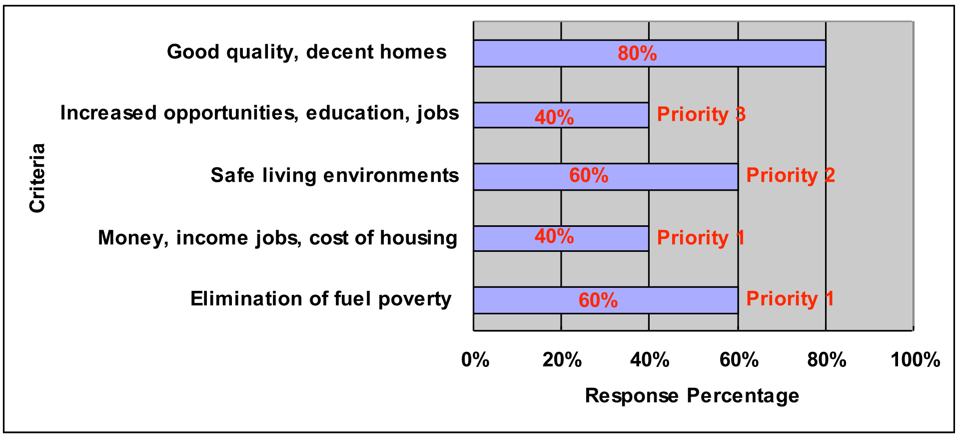


Figure (1) Criteria stated as important in improving a tenant's quality of life

All groups stated double-glazing and efficient heating as the priority one technology that can make a real difference in tenants' life. This illustrates the problem that is faced by current housing stock in failing in thermal comfort. Priority two, insulation is also dealing with basic thermal comfort and high lights the need to alleviate fuel poverty in the social housing sector. Three groups stated implementation of renewable technology measures but not a criterion listed by the managers. Area managers (involved with operations) gave priority to alternative energy & energy efficient measures only.

4.2 The Barriers in implementing Sustainable Technologies

Mentioned Barriers	Criteria Number1	Criteria Number2	Criteria Number3	No priority order
Initial cost, value for money, long payback periods	100%			
Tenants attitude- lack of interest, fear & behaviour		100%		
Structure of organisation			60%	
Lack of maintenance staff/ Reluctance to take risks				80%
Politics				60%
Legislation				40%

Table (2) Responses to the Q 3- what are the barriers in implementing these sustainable technologies in housing developments?

All participants agreed that the number one criterion, which acts as the barrier in implementing these sustainable technologies, is 'initial cost, value for money and long payback periods'. By popular consensus, 'tenants' attitude, lack of interest, fear & behaviour' came as the number 2 criterion. Three groups agreed that the 'structure of organisation' also play a key role in this process and sited it as number 3 barrier. Lack of maintenance staff, reluctance to take risks, politics and legislation were also cited as other barriers.

Decision making and prioritising the requirements that gets funding in a limited budget is a key process in any local authority strategy and policy. When presented with the question 'Criteria that influence the decision making process in allocating resources', the Housing Policy/ Strategy and Development group came up with a list that they thought best illustrate the crucial criteria and stressed the fact that funding issues span and govern all the other criteria as a major issue. The tabulated criteria were,

- Statutory requirements
- Achieving government targets (political connotations)
- Tenant interest requirements
- Good value for money (payback period, options)
- Annual budget
- Speed of delivery
- Lease holder tribunals

There were also discussions regarding the justification of resources for each requirement; issues pertaining to increasing rent to recover the capital cost; and the constraints held by the tenant tribunals in challenging each of the council's decisions regarding improvements to the housing stock. The level of deprivation in each scheme and its influence in the allocation of resources in refurbishment were also discussed as a governing factor. The dilemma faced by the strategic managers in the balance between achieving a little bit for a large number or a lot for a small number in terms of sustainability was presented as a key issue.

Q5, 'How do the tenants' feel about incorporating environment technologies in their houses?' was presented to the Neighbourhood managers and Community participation team who work closely with tenants. The community participation team mentioned;

> Lack of effective basic services, Lack of trust, Lack of information, Lack of credibility of green issues and lack of practical demonstrable examples as drawbacks and important in using innovative environment technologies.

The Neighbourhood Managers mentioned education, incentives, legislation & encouragement as important in this process. Area Managers (operational) & The Sustainability Team were presented with the Q6 'Improvements that will provide a better service to the tenants' and responded with the following criteria;

- Efficient organisation
- Change in subsidiaries
- Information/ education
- Rent options for added technology
- Environmental assessment
- Micro grid
- Grants
- CHP with individual controls

The social systems surrounding construction, especially housing production, resist change. This could be due to inflexible mindsets, socio-cultural values, or simply fear of change or taking risks. In order to achieve the full benefit of innovative technology, the user has to be familiar with its use. Educating the occupier is crucial to overcome these setbacks. Research carried out by Sustainable Homes (2003) showed that, given the right information and control, tenants are happy to implement new environment technologies in their dwellings. Savings in utility bills can be a major incentive in this process. Communicating information in a simple manner is crucial in engaging all types of stakeholders. Promoting and providing after sales support in innovative products and services, access to information systems, helpline services could all contribute to this process.

5.0 Discussion

The aim of the workshop was to identify management attitude towards sustainable refurbishment. The results and the discussions from the stakeholder consultations showed that many housing organisations are reluctant to implement innovative technologies due to fear of taking risks, and consider implementing only basic technology in their refurbishment programmes. A snapshot of case studies given in Green Street (Sustainable Homes, 2003) illustrates the current status of refurbishment and the savings that can be achieved with the most basic environmental upgrades in the short term. In many examples (Case study Sandwell, Green Street), refurbishment costs about 15% higher than for comparable conventional housing are considered a worthwhile investment, due to the fact that maintenance costs are likely to be much lower than for traditional council homes.

'It has been shown that, when designed carefully, innovative systems do not represent additional initial building costs. Running costs are lower and energy costs can be reduced by approximately 30% compared with conventional solutions' (Kragh, 2001). A series of barriers currently exist against the physical improvement of existing community neighbourhoods including planning system procedures, limiting opportunities for improvements and slowing progress. Further barriers exist to the implementation of improvement measures in existing homes including: unequal levels of VAT between new build (zero rated) and repairs and refurbishment (17.5% VAT) (Rowlands, 2007); barriers relating to access to finance for householders; householder apathy due to lack of interest or awareness; lack of information about how to improve properties; and landlord-tenant share of benefits where the landlord may invest in resource efficiency improvements but the tenant receives the benefits of reduced bills.

Consultation and engagement with stakeholders is good practice when developing an evidence base to inform future policy or initiate an innovative project. It helps to ensure that there is some degree of consensus around the information and evidence that will inform policy development regarding the project. This has the potential to reduce conflict during the development of policy and its implementation.

The responses and the results of the consultation illustrate the disparity that exists in the groups that work directly and reflect the aspirations of the tenants and the decision makers. While the managers attempt to drive the sustainable agenda forward and initiate implementation of innovative environment technologies, the sectors that directly work with tenants are trying to achieve the basic environmental criteria such as alleviating fuel poverty, installing double glazing or increasing levels of insulation in the dwelling facades and security needs in terms of surveillance. It also high lights the socio economic issues that have to be addressed before embarking on a major sustainable development programme. The problems in the implementation of various sustainable technologies where extra capital costs have to be justified and the dilemma the mangers face in their decision making process where a balance has to be struck in achieving the tenants aspirations while meeting the government agenda is also fully illustrated.

Unfortunately, six months after the workshop the organisation underwent a major management change and, by the time the new management team had been established and re-engaged with the research team there was insufficient time left in the project to put in place the recommendations from the workshop. However, the ideas from the workshop were incorporated into a wider study of innovation management within social housing refurbishment (results are still be analysed) and informed an action research project with another social housing provider that is still ongoing.

6.0 Conclusions

All stakeholder groups identified elimination of fuel poverty and finances as main criteria in 'Quality of Life' issues. Double Glazing, efficient heating and insulation are stated as the technologies that can make a real difference in a tenants' life stressing the need to alleviate fuel poverty and provide warm comfort conditions to the tenants. Even though the government has much more ambitious environmental efficient targets for the local authorities to achieve what is actually achieved in practice is basic refurbishment and upgrading standards. Surveillance technology is also desired in terms of providing a secure environment that enhances the wellbeing of tenants. These social issues and concerns can only be realised by engaging the stakeholders in dialogue and high lighting their needs and concerns.

Value for money, tenants Attitudes and structure of an organisation were identified as the main barriers in implementing new and innovative technologies. Level of deprivation and the balance between achieving 'a little bit for a large number or a lot for a small number' can have a major influence in the sustainable refurbishment of dwelling stock.

Real engagement is about asking what the questions should be (the risks, the agenda for change), how the issues should be addressed (process) and how success would be measured (outputs and measures). It goes beyond the way things have always been done in an organisation to discover what really matters to all the stakeholders and to get them involved in identifying the way things can be changed. The measure of the quality of such engagement has to reflect this aspiration and draw from the method itself and deliver in each case the measures of success that enable the stakeholders to talk in a shared language. In this case, lack of maturity in thinking about 'why and how they did what' within the hierarchy of the organisation was also noted. This key aspect is being taken forward by further research on the way housing associations perceive and rate their own sustainable credentials and the results will be published in the near future.

7.0 References

BREEAM- EcoHomesXB- http://www.breeam.org/page.jsp?id=25

Communities & Local Government, Quality and Choice: A Decent Home for All: The Housing Green Paper 2000

Communities & Local Government, 2006 Code for Sustainable homes http://www.communities.gov.uk/planningandbuilding/buildingregulations/legislation/codesustainable/

Communities & Local Government, Housing Statistics, 2009

English Housing Condition Survey, 2008

Irwin, A., Georg, S. and Vergragt, P. (1994) The social management of environmental change. Futures, 26(3), 323–34.

Kaatz, E., Root, D.S., Bowen, P.A. and Hill, R.C. (2005) Broadening project participation through a modified building sustainability assessment. Building Research & Information, 33(5), 441–54.

Kragh M., Monitoring of Advanced Facades and Environmental Systems, PhD Paper presented at The whole-life performance of facades, University of Bath, CWCT, 18/19 April 2001, Bath, UK.

Loorbach, D. and Rotmans, J. (2006) Managing transitions for sustainable development, in Olshoorn, X. and Wieczorek, A.J. (eds) Understanding Industrial Transformation: Views from Different Disciplines, Springer, Dordrecht, pp. 187–206.

Mathur V. N., Price A.D.F. & Austin S. (2008) Conceptualizing stakeholder engagement in the context of sustainability and its assessment, Construction Management and Economics, 26, 601–609

Newcombe, R. (2003) From client to project stakeholders Construction Management and Economics 21, 841–848

Choice or coercion: dilemmas of sustainable social housing. A study of two developments in Kent

CG Pickvance - Local Environment, 2009 - Routledge, part of the Taylor & Francis Group

Sustainable Homes, 2003, http://www.sustainablehomes.co.uk/

Sustainable Development Commission, 2005, http://www.sd-commission.org.uk

Rowlands, J. (2007) VAT on refurbishment, RICS

A proposal for discursive methods of stakeholder involvement in healthcare project decision-making

Ruth Sengonzi

Loughborough University, UK

The NHS is undergoing change. Some recent initiatives include introduction of the 'Patient and Public Involvement' initiative and the 'Strengthening Accountability' guidance by the Department of Health. These and others have resulted in improved effort towards fully engaging staff, patients and the public in the design and delivery of healthcare services. Current research work of which this paper is part, investigates possibilities for better ways of delivering Whole Life Value (WLV) of healthcare facilities for the benefit of all stakeholders. This investigation targets the pre-design stages of healthcare projects. Consequently, this paper is based on the recent changes within the National Health Service (NHS) primary care facility acquisition guidance and its sustainability agenda, which entail that all stakeholders are involved in the planning of services that affect them. However, with a sector like this engaging stakeholders, the first challenge is that in one way or another, virtually every citizen is a healthcare sector stakeholder. The second challenge is that the different stakeholders each have their own needs and expectations, which may at times conflict. The third challenge noted is one of effectively engaging these stakeholders and from this several questions arise: Who is to be engaged? What contribution is expected of them? When and how do we effectively engage them? Based on Renn et al.'s 1997 'cooperative discourse' method, a stakeholder participation model is proposed for application in the pre-design stages of healthcare projects. In the model, the three step 'cooperative discourse' process is combined with value management (VM) methodology to create a synergistic effect. The premise of the 'cooperative discourse' procedure is that all stakeholders play a role at each stage but they are encouraged to impact the decision process with the specific knowledge with which they are most proficient. Combined with the advantages of VM methodology, the proposed model is intended to lead to a method for dealing with the afore-mentioned challenges. A literature review on the stakeholder engagement process has been conducted. The peculiarities that may abound when the NHS engages all its stakeholder groups in planning of infrastructure have also been discussed. The aim of this preliminary investigation has been to identify and verify the need for a stakeholder engagement model and to identify its usefulness in the context of the NHS. The paper draws conclusions in the final section and proposes to take the model into the next stage which will be to validate it with NHS primary care management, community representatives and focus groups. Issues raised will then be carried forward to inform an on-going research project.

Keywords: Value Management, cooperative discourse, engagement, healthcare projects, stakeholders

1.0 Introduction

Health is the state of complete wellbeing and not merely absence of disease (WHO 1948). The term healthcare facilities (synonymously used with healthcare buildings) is used here to refer to those structures in which health is restored or nurtured. The Sir Winston Churchill saying "we shape our buildings, thereafter they shape us" is increasingly being validated by empirical evidence. The built environment has been found to influence human behaviour (for example, Bordass and Leamann 1997), while recent research further indicates that healthcare facility design and built environments impact on patient wellbeing and staff performance (Lawson and Phiri 2003). This highlights the need to understand and manage the stakeholders in order to minimise negative impacts of healthcare buildings on the people (health and wellbeing) and to a greater extent the locality (urban sustainability).

Building construction projects are generally divided into several stages representing different activities and levels of building completeness and use (Gambatese *et al.* 2007). The construction industry has been reported to often rush into projects without adequate understanding of the importance of the early phases (Emmitt 2007). It has also been known to make decisions predominantly based on the capital (initial) cost of a facility (Holti *et al.* 2000; Woodhead 2000). However, it is in the less-emphasised pre-design stages that fundamental decisions regarding major issues in the life cycle of the facility are made (Duerk 1993; Yu *et al.* 2007).

This paper is based on pre-design activity. It attempts to portray the worth of spending more time in trying to engage with and understanding stakeholders as part of key planning activity. The paper also relates to how the social facet of sustainability can be utilised in decision support to enhance the other aspects of sustainable development especially in realising the functional value of a healthcare facility. The proposed 'cooperative discourse' and Value Management (VM) methodology, mainly workshop-based activities, heavily relies on the social aspect of communication. This may include *hearing* and *listening*, understanding and sharing of information as well as compromising positions [amongst the three aspects: economic, social and environmental] in order to achieve common good.

.1 Background and Justification

Sustainability is often defined from the context of the World Commission on Environment and Development report (WCED 1987). This report highlighted the argument that promoted sustainable development that ensures that it meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development is believed to address the prudent use of natural resources and human potential, drawing together an even wider set of factors for consideration including global resources, urban design, social development, building and landscape design and engineering as well as operational consequences in terms of staffing, revenue funding and maintenance (Francis, 2004). Construction management literature (for example Kagioglou *et al.* 2000; Kirkham 2006) along with UK government guidance (OGC 2004) recognise the importance of considering the construction project through a broader whole life cycle perspective. This perspective accounts for all life cycle activities and impacts of early decisions on the finished product, right from its inception, design, construction and through to its use and disposal. However, the whole life cycle debate has mainly been steered towards cost considerations, towards, whole life cycle costing (WLCC). Upon recognising the broader effects that construction activities and products may have on those (stakeholders) who may participate in developing and using the finished product over the long term, theory on WLV is emerging. Bourke *et al.* (2005) believe WLV of an asset to represent an optimum balance of stakeholders' aspirations, needs and requirements, and whole life costs. They further consider it to encompass economic, social and environmental aspects associated with design, construction, operation, and decommissioning, and where appropriate the re-use of the asset or its constituent materials at the end of its useful life. In principle, the WLV phenomenon shares many tenets with sustainable development, therefore, tracking metrics of WLV can be used to deliver a sustainable solution.

Furthermore, the Government is committed to empowering both individuals and communities so that they can play a greater role in shaping health and social care services (DH 2008a). An ideological shift to representing the public as consumers requiring evidence as a basis for informed choices (Taylor 2005) is demonstrated by the introduction of such initiatives as *"Patient and Public Involvement" (PPI)*, (DH 2008a) and *'Strengthening Accountability'* (DH 2003). Through the *NHS Plan* (DH 2000) power was devolved to frontline primary care staff, to the Strategic Health Authorities (SHA) and Primary Care Trusts (PCTs). They were henceforth empowered to plan and be actively involved in all matters pertaining to service design. The recently introduced 'consumerism' and 'design quality' agendas for planning primary care premises also focus on the patient as customer (PCC 2008). Similarly, the inclusion of sustainability standards (DH 2008c) to be adhered to in NHS facility planning is also relatively new. All these drive the move towards improved service delivery through involving and engaging with staff, patients and the public in service design and consequently in the planning of healthcare facilities.

It may be noted that such recent NHS initiatives take effect as soon as they are launched. These initiatives, as well as the WLV phenomenon represent an unprecedented challenge to the usual procedures of acquiring and making decisions especially in the pre-design stages. Involving stakeholders in pre-design activity implies a need to improvise ways to make the recent changes viable. The already complex and dynamic healthcare sector (Miller and Swensson 2002) further has to face up to the challenges presented in involving multiple stakeholders in the crucial pre-design phase; that, as noted above, involves making critical decisions. The proposal for a 'cooperative discourse'/VM methodology is envisaged as relevant in attempting to resolve some of the issues surrounding the conflicting differences that are likely to occur when a number of time-bound decisions need to be made by several stakeholders. It seeks to define a balanced way of involving all, but only to an extent such that stakeholder groups are required to contribute to their area of proficiency. The end result of this interactive planning represents an amicable division of labour that seeks to deliver the 'best' final result in the finished facility.

2.0. Literature review

2.1 Sustainable development and healthcare facilities

Construction industry activities virtually impact all human beings. From the three-tiered sustainable development perspective, the built environment is believed to provide a synthesis of environmental, economic and social issues through provision of shelter, physical infrastructure to communities and for being a significant part of the economy (Prasad and Hall 2004). Moreover, constructed buildings are usually characterised by a unique physical permanency and fixity (Nutt 1993). Therefore, the impacts from construction activity and finished products may not be reversible and hence are bound to be felt over a long term. With regard to hospitals, that, in scale and complexity sometimes compare to a small town with a service, industrial and residential area all in one (Arntzen 2003), the collective impacts could be colossal. Consequently, the value gained from a built healthcare facility should be based on attempting to minimise the negative outcomes of construction projects while at the same time maximising the positive impacts.

2.2 Sustainable development in NHS facilities

The environment in which people live and work is said to have a key influence on their health. For this reason, the Department of Health (DH 2008a) has decreed that environmental considerations be taken into account when building or adapting facilities in which NHS services are delivered. It has been noted that "for trusts involved in providing NHS facilities, progress towards environmental aims will need to be offset against economic considerations. Whole life costs and life cycle assessment should be balanced against environmental impacts and benefits, giving the three tiers of sustainable development". However, Turner (2006) has noted that, the aspiration to integrate environmental concerns into all aspects of social and economic life brings unexpected cultural, social and political challenges. He further suggests that in order to cope with these challenges, existing systems need to be modified by more participatory systems.

2.3 Capturing value : Stakeholder engagement and involvement

2.3.1 Stakeholders

Freeman (1984) defined stakeholders as individuals or groups who may affect or be affected by the achievement of the organisation's objectives. His definition seems to signify that organisational survival and success that is dependent on understanding and engaging with stakeholders. In addition, Johnson *et al.* (2008) affirm that an organisation depends on its stakeholders. While, Anderson (1982) suggested that managers ought to balance the interests of all stakeholders to optimise organisational effectiveness. These groups or individuals have a stake in the organisation, where, stakes are defined as the interests of stakeholders which can last either a short or long time, and may have cultural or political orientations (Mintzberg *et al.* 2004). It is believed that, for any organisation, specific interest groups (stakeholders) exist in its business environment and these have an impact on the success and effectiveness of the organisation (Jonker and Foster 2002). Blyth and Worthington (2001) place stakeholders into two broad groups: the demand side and supply side stakeholders. For healthcare construction projects the groups could further be subdivided as shown in Figure 1. The distinction is important in order to recognise that each group has different needs, expectations and objectives. Moreover, it has been noted that conflicting interests are likely to occur in any organisation with multiple stakeholders (Green 1996; Newcombe 2003). Therefore by recognising and identifying all the groups, the organisation may determine the best way to reach out to them and capture their needs and requirements and ultimately their values.

DEMAND SIDE	SUPPLY SIDE (supply chain)

▪ Users – Full time (staff)
  o Patients
  o Visitors
▪ Client Advisors
▪ Client
▪ Funders
▪ Legislators
▪ Community/Pressure Groups
	▪ Designers
	▪ Consultants
	▪ Contractors
	▪ Suppliers
	▪ Facilities Managers

Figure 1: Health facility stakeholders

2.3.2 Stakeholder engagement and involvement

In the construction industry, client and stakeholder value (needs and requirements) are captured through the briefing process. One way of gaining insight into what the client organisation and its wider stakeholder base value in a project is first identifying who the stakeholders are and then initiating direct engagement with them right from the start/inception. Through engagement and direct involvement with a client organisation, stakeholder needs are identified and prioritised to ensure that the optimum combination of benefit and costs is secured.

The concept of "engagement" is believed to potentially span passive and active modes of engagement which include: disclosure and transparency by organisations to their stakeholders, and direct involvement, consultation or partnership with stakeholders (IISD 2004). Jonker and Foster (2002) recognize stakeholder engagement as a complex multi-dimensional process with multiple components that need to be considered separately and from several angles. The components are 'parties', 'processes', 'stake', and 'connections', from which they construct a useful matrix for analysing stakeholder engagements.

INVOLVE (2005) identifies several benefits of stakeholder participation and engagement. They suggest benefits such as, greater social cohesion; improved quality of service, projects or programmes; and, greater capacity building and learning among others. However, Holt (2001: 149) argues that "involving these stakeholders throughout the facility 'life' can cause costly interruption to service delivery, as well as reflecting unduly the interests of a powerful or vocal minority" Therefore, the challenge is to innovate ways through which to maximise positive benefits attainable from stakeholder involvement or engagement. Appelbaum *et al.* (1999) report that a participative climate, also shown to be related to empowerment, helps staff to believe they are important assets in the organisation and can make a difference.

3.0 Findings and discussion

3.1 Patient and Public Involvement in the NHS

Section 11 of the Health and Social Care Act 2001 (now S242 of the consolidated NHS Act 2006) places the duty on NHS Trusts, PCTs and SHAs to make arrangements to involve and consult patients and the public in service planning and operation and in the development of proposals for changes. However, the multiple stakeholder characteristic of the NHS has been cited as a major challenge to the procurement and acquisition of modern healthcare facilities (EPSRC 2008). Furthermore, the characteristic healthcare dynamics (Miller and Swensson 2002) that usually result in policy and practice changes call for a 'post-normal' science (Funtowicz and Ravetz 1994). In this, quality is the organising principle and it entails the democratization of knowledge by an extension of the peer-community [all stakeholders] for quality assurance, thereby encompassing the multiplicity of legitimate perspectives and commitments. Such a 'post-normal' science is also understood to provide new forms of discourse.

A discourse is said to refer to a set of meanings, metaphors, representations, statements and so on that in some way together produce a particular version of events (Burr 2003). Foucault (1972) thought that a discourse constructs a topic; governing the way it can be talked about and reasoned about. Therefore, it can be argued that, discourses make it possible for us to perceive the world in a certain way (Burr 2003). Furthermore, Rosenhead (1980) believed planning to be a social activity which therefore necessitates one expression of those social forces which are embodied in the social institution. From a WLV perspective, sustainable decision making may require the consideration of intricate linkages between environmental, economic and social aspects. In addition, sustainable decision processes are said to require the active engagement of stakeholders (Antunes *et al*. 2006) involved in collective discourses in order to construct a collective understanding of a problem or challenge.

3.2 Proposal: Cooperative Discourse Method and VM

Freeman (1984) recognised that organisational interactive relationships with stakeholders could be perceived as a process. It is through understanding these relationships that an organisation identifies how to engage with its stakeholders. This process, he felt could be analysed at three levels: '*rational*', that addresses stakeholder identity and perceived stakes in the organisation; '*transactional*', focused on dealings between the organisation and its stakeholders; and, '*processional*', which is about the processes used to manage the relationships. The proposed 'cooperative discourse'/VM combined methodology targets the processional level in order to attempt to solve the problem with multiple groups of stakeholders each with a varied level of specialty or expertise with regard to pre-design phase knowledge and information. The premise of this proposal to link the two is that "the long-term performance of any construction and its ability to satisfy stakeholder requirements depends on the decisions made and on the care taken by decision makers in stakeholder communication" (Olander and Landin 2008: 554). Applying the synergistic model is envisaged to lead to improved decision making within a refined communication system involving all stakeholder groups and expert guidance but within the limits of their knowledge.

It has been noted that in order for management to take into account the influence of external groups on the process of direction-setting, it requires the introduction of certain internal procedures to ensure that this is done systematically (Jonker and Foster 2002). Direction-setting processes are typical of pre-design project- and design-strategy activities that both NHS internal and external groups must now be involved in.

3.3 A three step model of public involvement: "cooperative discourse"

Renn *et al*. (1997) noted that without a systematic procedure to reach consensus on values and preferences, the stakeholders' position often appears unclear. They perceived that participatory processes that combine technical expertise, rational as well as moral decision-making, and public values are needed. Processes such as negotiation, mediation and arbitration are suggested solutions. They further noted that successful mediation among a wide variety of stakeholders has been attempted through round table discourses (named cooperative discourse).

The 'cooperative discourse' model entails:

(i) Identification and selection of concerns and evaluative criteria

Best accomplished by asking all relevant stakeholder groups (i.e. socially organized groups that are or perceive themselves as being affected by the decision) to reveal their values and criteria for judging different options. At this point, it is said to crucial that all relevant value groups be represented and that the value clusters be comprehensive and include economic, political, social, cultural and religious values – use of value-tree analysis appropriate at this stage.

(ii) The identification and measurement of impacts and consequences related to different policy options

Evaluative criteria derived from the value-tree are operationalized and transformed into indicators by the research team or an external expert group. These operational definitions and indicators are reviewed by the participating stakeholder groups. Once approved by all parties, these indicators serve as measurement rules for evaluating the performance of each policy option on all value dimensions. Experts from varying academic disciplines and with diverse perspectives on the topic of the discourse are asked to judge the performance of each option on each indicator – The objective is to reconcile conflicts about factual evidence and reach an expert consensus via direct confrontation among a heterogeneous (diverse) sample of experts in the field. At the end of this step, performance profiles for each option are constructed which reflect the strengths and the weaknesses of each option on each indicator.

iii) Conducting a rational discourse with randomly selected citizens as jurors and representation of stakeholder groups as witnesses

The last step is the evaluation of potential solutions by one group or several groups of randomly selected citizens (Dienel 1978; 1989) – citizen panels. These panels are given the opportunity to evaluate the design policy options based on the knowledge of the likely consequences and their own values and preferences. The participants are informed about the options and the consequence profile generated by the experts in *Step (ii)* before they are asked to evaluate these options on each dimension identified in the value tree process *(Step i).* At this level, stakeholder group representatives and experts – both as witnesses, provide their arguments and evidence to the panels who ultimately decide on the various options.

The deliberation process is said to take time: citizen panels are normally conducted as seminars over 3-5 days. The three groups (experts, stakeholder groups and the general public) play a role in each step, *but they are encouraged to impact the decision process with the specific knowledge with which they are most proficient:*

- The stakeholder groups have the most proficient and diverse knowledge of evaluative criteria;
- The experts have the best systematic knowledge about factual performance; while,
- The citizens have an appropriate and legitimated deliberation potential to weigh benefits and risks.

For healthcare projects, a major benefit of the cooperative discourse methodology is that, this division of labour provides a check-and-balance process and a sequential order for multiple actor involvement. Applied in combination with VM methodology, the benefits of this model will further be enhanced.

3.4 Value Management (VM) and Soft Value Management (SVM)

3.4.1 Value Management

As seen earlier, sustainable development and WLV are closely related to optimal use of resources related to economic, social and environmental aspects of facilities. Likewise, VM is a renowned methodology for achieving value for money in building projects. A building is said to offer value for money when the benefits derived from it, significantly exceed its lifetime costs (Building 2000). These benefits are further said to be derived from the functions that a building performs rather than from the building itself. VM has been defined as "a process in which the functional benefits of a project are made explicit and appraised consistent with a value system determined by the client" (Kelly *et al.* 2004: 1). Best and de Valence (1999) reported that VM presents an opportunity for project stakeholders to exchange different views and perspectives, hence enabling them to avoid many of the problems typical of building projects, in addition to satisfying the demand for long-term value. As an organised approach towards defining client's value in meeting his needs and in delivering that value throughout the product delivery process, VM helps clients to control their investment (in construction) in order to ensure that the product is valuable and cost effective to use and to maintain.

Hayles (2004) suggests a VM approach to enable clients contribute to a better built environment and ultimately the opportunity to stimulate improvements in the construction process. A VM service is said to involve: Functional Analysis (FA); Life-Cycle Costing; operating in multi-disciplinary work groups; and, establishing the comparative cost in relation to function.

3.4.2 Soft Value Management (SVM)

Not contented with traditional 'hard' VM/VE practice as discussed above, some proponents of 'Soft Value Management' (Green 1994; Liu 2002) thought there was cause for improvement. They thought that the traditional VM was rooted in hard systems methodology which were consequently only effective in solving 'hard' technical problems. Liu (2002) observes that such 'hard' problems are always manifested as a pursuit for cost reductions or function-related values. SVM is founded in, Soft Systems Methodology (SSM) (Checkland 1981; 2000), an accommodating learning system that integrates conflicting interests among participants. SSM emphasises learning , human content, epistemologies and system models using social problems to solve soft and ill-illustrated problems. SVM models have therefore been innovated to take care of the softer intangible issues associated with 'values' in the value alignment process. This is more of the case in the pre-design stages when the project is not completely defined, and one of its aims is to reach consensual agreement with stakeholders (Dallas and Humphrey 2004). Moreover Ward and Chapman (2008) recognise that most project manifest higher 'soft' features early in conception, early design and strategic planning than in the later stages of the project's life cycle. SVM may therefore be thought to be useful in supporting a group of people seeking to make sense of, and collectively act in a situation in which they are empowered (Shen *et al.* 2004); for example when participating in a discourse.

3.5 Benefits of using VM approach

Used in combination with VM, SVM will balance out the inadequacies associated with traditional VM thereby maximising the benefits of the service. Connaughton and Green (1996) reported the main benefits arising from the application of VM as achievement of value for money; improved communication and team working; a shared understanding among key participants; better quality project definition; increased innovation; and, the elimination of unnecessary cost. Alternatively, the Institute of Value Management (IVM 2008) identifies a range of similar but more explanatory merits: better business decisions by providing decision makers a sound basis for their choice; improved products and services to external customers by clearly understanding, and giving due priority to their real needs; enhanced competitiveness by facilitating technical and organisational innovation; and, a common value culture, thus enhancing every member's understanding of the organization's goals decisions which can be supported by the stakeholders.

Furthermore, VM boasts the basic focus of assessing the relationship between function, cost and worth. It is likely that what makes VM a strong integrating method or system, is its application of functional analysis and other problem solving tools and a multi-disciplinary team to analyse a project. It is a good system for integrating the project stakeholders: the end user, the client, design/building team. Dallas and Humphrey (2004) argue that because every building project should have clearly stated objectives expressed in terms of benefits sought by those who commission it, VM is important. It decomposes these objectives into a number of what they call functional 'value drivers', where functional, refers to what things it must do in order to contribute to the objectives. When a VM service is used proactively it has the capacity to align value systems from the outset and to ensure that a project progresses effectively and efficiently and that appropriate decisions are taken in light of the fact that it costs money to retrace footsteps (Male *et al.* 2007).

3.6 VM and discourses

Connaughton and Green (1996: 7) depict VM as a "structured approach to defining what 'value' means to a client when meeting a perceived need, and delivering that value via the design and construction process". It is a structured approach to defining the meaning of client value in meeting a perceived need by establishing a clear consensus [discourse] about the objectives and how they can be achieved. Usually applied as part of structured problem-solving procedure in the early stages, its primary objective is reportedly to develop a common understanding of the design problem, identify explicitly the design objectives and synthesize a group consensus [discourse] about the comparative merits of alternative courses of action (Green 1994).

VM derives its power from being a team approach that uses functional analysis to examine and deliver a product , service or project at optimum whole life performance and cost without detriment to quality (Male *et al.* 2007). According to Kelly *et al.* (2004), VM is distinguished from other management disciplines by three core factors: a value system; a team-based process; and, the use of function analysis to promote in-depth understanding. From a discursive perspective, it has been shown to deliver other benefits for example consensus building among stakeholders (Green 1994); project learning (Barton 2000); sense-making (Thiry 2001); and, participatory goal-setting (Liu and Leung 2002), among others.

An enhanced step-by-step model (Figure 2) of VM/SVM methods embedded in Renn *et al.*'s 'cooperative discourse' is envisaged to improve value definition and understanding in pre-design processes. In the figure, sub-activities (Step 1-3) are carried out in sequence from the left to right, while the main participating groups (actors) are presented from top to bottom on the left hand side. Each step of the process is expected to lead to specific deliverables which are shown at the bottom of the figure similarly represented from left to right. For each step of the process, the lead actor in the particular activity together with their expected task has been highlighted in the diagram. The figure also shows that each of the leading tasks is to be corroborated with a VM/SVM service. Based on VM workshop methods, participants are provided with a forum for communication and for resolving any conflicts. The use of VM FAST will further aid in aligning functional requirements of the facility as well as providing for a systematic way of ensuring that none of the pertinent 'hard' issues are missed in the heat of the 'soft' issues that may take precedence when the various stakeholder groups need their voice to be 'heard'.

It may further be noted that, even with a mediated discourse, stakeholders may still disagree as to what the solutions are. However, it has been noted that, with the established relationships and interactions, solutions remain a possibility (Holt 2001). It has been said that, there is no solution optimising all criteria at the same time, hence compromises have to be found (Antunes *et al.* 2006). "There is responsibility for those who take part to ensure what they say is relevant to the problem or problems at hand" (Little *et al.* 2002: 1084), and further that, each party to the discourse has a duty *listen* to as well as to *hear*. This is said to imply that all discourse participants must bear some responsibility for making the discourse work. Therefore, by engaging all stakeholder groups (through their representatives) in the cooperatively discursive decision making process, they will all be party to the decision taken. Furthermore, involvement of future users as part of the key stakeholder group composition in healthcare projects has been cited as the best guarantee for project success (Arntzen 2003). Renn *et al.* (1997) and Earl and Clift (1999) observed that an effective stakeholder discourse depends on: sufficient time for debate; the result must not be a forgone conclusion such that the consultation is just a ratification process; and, equal access to debate by all stakeholder groups. Other conditions have been cited as, a willingness to accept the legitimacy of other points of view resulting from various reasoning and forms of knowledge; as well as, the necessity to accept technical, anecdotal and emotional evidence as being equally valid.

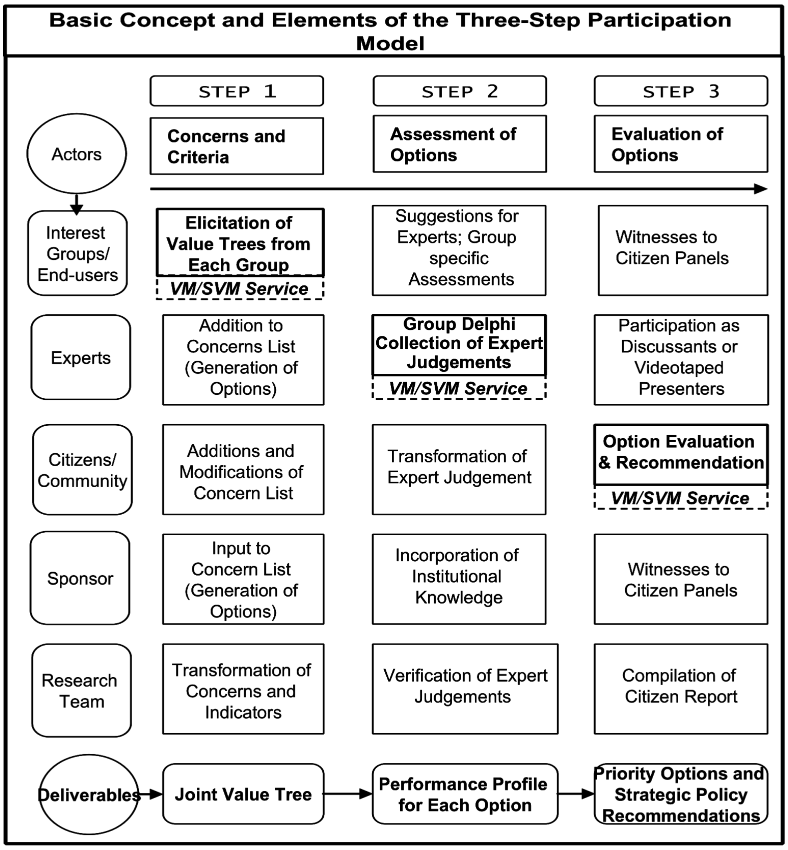


Figure 2: A VM enhanced stakeholder participation model

(Adapted from three-step participation model by Renn *et al.* 1997)

4.0 Conclusion

The importance of successful pre-design decision-making in WLV delivery has been highlighted towards the end of *Section 1.0.* As demonstrated throughout this paper, of the three facets of sustainability, there is reason to perceive the social facet as a primary pillar of WLV definition during pre-design activity. Successful WLV definition in the pre-design stages will lead to guided pursuance and achievement of this very WLV through to the end of life of the facility. Firstly, effective briefing and consequently requirements capture will involve the delivery team in social discourses and processes identifying and engaging with the stakeholders to enhance the team's understanding of what the 'real' project needs and eventual use value are. Secondly, social sustainability will also support whole life cycle project information dynamics and decision-making including transparent information exchange throughout the process.

In this paper we have presented the potential of the *cooperative discourse* method complemented synergistically by VM methodology. The resulting methodology has been shown as a powerful way of supporting the implementation of multi-stakeholder participative value definition and decision making. In relation to the WLV phenomenon therefore successful value definition and collaborative decision-making is envisaged to lead to a more sustainable solution over the project's life cycle in the light of all the issues enumerated by WLV definition. Cooperative discourse may particularly be useful in dealing with ill-structured problems, for which there are various possible perspectives, typical of pre-design stages of construction projects. Moreover, with healthcare facility projects, having to deal with several stakeholders each with their needs and expectations, amidst changing policies, several issues will need to be resolved and multiple feedbacks reconciled in order to agree a common position on how to take the project forward. The use of a combined approach, as suggested in this paper, can have a synergistic effect, combining the advantages of cooperative discourse and the proven benefits of VM in construction projects. Subsequently, improved decision-making processes that fully support amicable stakeholder engagement may be achieved.

The pre-design phase happens early on in the project, at a point when a wide range of opportunities are available for potential value creation and improvement. Consequently, a VM study is most useful then. VM when combined with the cooperative discourse principles of team selection would involve a varied selection in facilitated group discussion thereby benefiting from input of key stakeholder groups. In addition, ownership and commitment to the outcomes of the process and the final product when it is completed would be achieved.

This paper is part of ongoing research work. Following this proposal, the model is to be validated in consultation with relevant individuals in NHS primary care planning management, community representatives and focus groups. Issues raised will then be carried forward to inform an on-going research project.

References

Anderson (1982) Marketing Strategic Planning, and Theory of the Firm. *Journal of Marketing,* 42 (Spring)**,** 15-26.

Antunes, P., Santos, R. & Videira, N. (2006) Participatory Decision Making for Sustainable Development - the Use of Mediated Modelling Techniques. *Land Use Policy,* 23**,** 44 - 52.

Appelbaum, S. H., Hébert, D. & Leroux, S. (1999) Empowerment: Power, Culture and Leadership – a Strategy or Fad for the Millennium? *Journal of Workplace Learning,* 11 (7)**,** 233-254.

Arntzen, E. (2003) Buildings - from Concept to Use. *Business Briefing: Hospital Engineering and Facilities Management***,** 38-45.

Best, R. & De Valence, G. (1999) *Building in Value: Pre-Design Issues,* London, Arnold Publishers.

Blyth, A. & Worthington, J. (2001) *Managing the Brief for Better Design,* LONDON and NEW YORK, SPON PRESS.

Bordass, B. & Leaman, A. (1997) Future Buildings and Their Services: Strategic Considerations for Designers and Clients. *BUILDING RESEARCH & INFORMATION,* 25**,** 190-195.

Building (2000) Value for Money - Cost Model. *Building.*

Burr, V. (2003) *Social Constructionism (2nd Ed.)* London ; New York : , Routledge.

Checkland, P. (1981) *Systems Thinking System Practice,* Chichester, Wiley.

Checkland, P. (2000) Soft Systems Methodology: A Thirty Year Retrospective. *Systems Research and Behavioural Science***,** S11-S58.
Connaughton, J., N., & Green, S. D. (1996) *Value Management in Construction : A Client's Guide,* London, CIRIA.
Dallas, M. F. & Humprey, S. (2004) Value or Cost? *The value manager, HKIVM,* 10 11-14.
DH (2000) The NHS Plan: A Plan for Investment. A Plan for Reform. London, Department of Health, HMSO.
DH (2003) Strengthening Accountability - Involving Patients and the Public: Practice Guidance. London, Department of Health.
DH (2008) Patient and Public Involvement. Available from:http://www.dh.gov.uk/en/managingyourorganisation/patientandpublicinvolvement/dh_085874. Accessed: 03/08/08 London, Department of Health
DH (2008c) Sustainable Development in the NHS, Available At: http://www.dh.gov.uk/en/managingyourorganisation/estatesandfacilitiesmanagement/sustainabledevelopment/dh_4119123, Accessed: 05/11/08. London, Department of Health.
Duerk, D. P. (1993) *Architectural Programming: Information Management for Design,* NY, Published 1993
Earl, G. & Clift, R. (1999) Stakeholder Value Analysis: A Methodology for Integrating Stakeholder Values into Corporate Environmental Investment Decisions. *Business Strategy and the Environment,* 8**,** 149-162.
Emmitt, S. (2007) *Design Management for Architects,* Oxford, Blackwell Publishing.
EPSRC (2008) Health and Care Infrastructure Research and Innovation Centre (Haciric): Details of Grant. Available At: http://gow.epsrc.ac.uk/viewgrant.aspx?grantref=ep/d039614/1 accessed 02/03/08. Engineering and Physical Science Research Council (EPSRC).
Foucault, M. (1972) *The Archaeology of Knowledge; Translated from the French by A.M. Sheridan Smith.* , London, Tavistock Publications.
Francis, S. (2004) Investing in Design: Developing a Business Case for Good Design for Health. *Business briefing: Hospital Engineering and Facilities Management***,** 1 - 5.
Freeman, R. E. (1984) *Strategic Management: A Stakeholder Approach,* Boston, Pitman.
Funtowicz, S. & Ravetz, J. (1994) The Worth of a Songbird:Ecological Economics, as a Post-Normal Science. *Ecological Economics,* 10**,** 197-207.
Gambatese, A., Pocock, J. & Dunston, P. (2007) *Constructability Concepts and Practice*, American Society of Civil Engineers.
Green, S. D. (1994) Beyond Value Engineering: Smart Value Management for Building Projects. *Internation Journal of Project Management* 12**,** 49 - 56.
Green, S. D. (1996) A Metaphorical Analysis of Client Organizations and the Briefing Process. *Construction Management and Economics,* 14**,** 155 - 164.
Hayles, C. (2004) The Role of Value Management in the Construction of Sustainable Communities. *The value manager, HKIVM,* 10**,** 15-19.
Holt, R. (2001) Creating Whole Life Value Proxemics in Construction Projects. *Business Strategy and the Environment,* 10**,** 148-160.
Holti, R., Nicolini, D. & Smalley, M. (2000) *The Handbook of Supply Chain Management (C546): Building Down Barriers,* London, CIRIA
IISD (2004) Issue Briefing Note: Stakeholder Engagement, Iso and Corporate Social Responsibility. Winnipeg, Manitoba,Canada, International Institute for Sustainable Development (IISD).
INVOLVE (2005b) The True Costs of Public of Participation. INVOLVE.
John Wiley and Sons
Johnson, G., Scholes, K. & Whittington, R. (2008) *Exploring Corporate Strategy: Text and Cases. 8th Edition.*

Jonker, J. & Foster, D. (2002) Stakeholder Excellence? Framing the Evolution and Complexity of a Stakeholder Perspective of the Firm. *Corporate Social Responsibility and Environmental Management,* 9**,** 187 - 197.

Kelly, J. & Male, S. (1993) *Value Management in Design and Construction,* London, E& FN Spon.

Kelly, J., Male, S. & Graham, D. (2004) *Value Management of Construction Projects,* Oxford, Blackwell Science.

Lawson, B. R. & Phiri, M. (2003) *The Architectural Healthcare Environment and Its Effects on Patient Health Outcomes,* London, The Stationery Office.

Liu, A. M. (2002) Developing a Soft Value Management Model. *Internation Journal of Project Management,* 20**,** 341 - 349.

Male, S., Kelly, J., Gronqvist, M. & Graham, D. (2007) Managing Value as a Management Style for Projects. *Internation Journal of Project Management,* 25**,** 107-114.

Miller, R. L. & Swensson, E. S. (2002) *Hospital and Healthcare Facility Design,* New YORK, Norton and Company.

Mintzberg, H., Lampel, J., Quinn, J. B. & Ghoshal, S. (2004) *The Strategy Process: Concepts, Contexts and Cases,* Harlow, Pearson Education Ltd.

Newcombe, R. (2003) A Stakeholder Mapping Approach. *Construction Management and Economics,,* 21**,** 841-848.

Nutt, B. (1993) The Strategic Brief *Facilities* 11**,** 28 - 32

Olander, S. & Landin, A. (2008) A Comparative Study of Factors Affecting the External Stakeholder Management Process. *Construction Management and Economics,* 26**,** 553-561.

PCC (2008) Primary and Social Care Premises - Planning and Design Guidance. Available at: http://www.primarycarecontracting.nhs.uk/planning-and-design-guidance.php?routemap_id=5&process_id=14&sub_process_id=0&activity_id=106. *the process.* London, Department of Health.

Renn, O., Blattel-Mink, B. & Kastenholz, H. (1997) Discursive Methods in Decision Making. *Business strategy and the environment,* 6**,** 218-231.

Rosenhead, J. (1980) Planning under Uncertainty: 1. The Inflexibility of Methodologies. *Operational Research* 31**,** 209-216.

Shen, Q., Li, H., Chung, J. & Hui, P. (2004) A Framework for Identification and Representation of Client Requirements in the Briefing Process. *Construction Management and Economics,* 22**,** 213-221.

Turner, R. K. (2006) Sustainability Auditing and Assessment Challenges. *Building Research and Information,* 34(3)**,** 197 - 200

Ward, S. & Chapman, C. (2008) Stakeholders and Uncertainty Management in Projects. *Construction Management and Economics,* 26**,** 563-577.

WCED (1987) Our Common Future. Oxford World Commission on Environment and Development.

WHO (1948) Preamble to the Constitution of the World Health Organization, Available at http://www.who.int/about/definition/en/print.html, Accessed 15/10/08. *International Health Conference.* New York, World Health Organisation.

Woodhead, R. M. (2000) Investigating of the Early Stages of Project Formulation. *Facilities,* 18, 524-534.

Yu, A., Shen, Q. & Kelly, J. (2007) An Empirical Study of the Variables Affecting Construction Project Briefing/Architectural Programming. *International Journal of Project Management,* 25**,** 198-212.

Design and Access Statements as an assessment tool to promote quality sustainable development: reflections on practice in NE England

Elaine Paterson

Northumbria University, UK

Planners play an important role in seeking sustainable urban design solutions, including making critical decisions on planning applications. Design decisions in planning have frequently been controversial and criticised as being subjective and too interventionist. Decisions on the design element of proposed developments are arrived at, by local planning authorities, using information provided by the applicant/developer, consideration of relevant local and national policy, observation by planners on site, views from the public and statutory consultees, negotiation between developers and planners and finally views of local councillors. This is a complex set of information and ways to clarify and expedite such decisions are needed. One recent attempt by the government to do this followed the Planning and Compulsory Purchase Act, 2004. Regulations came into force in August 2006 requiring developers to submit a Design and Access Statement (DAS) with most applications.

A DAS is intended to assist design decision making in the planning process by clarifying the design approach of the applicant from the outset, so facilitating greater common understanding by all concerned. It appears the government is currently supporting constructive intervention by planning authorities on design issues, and so reinforcing the legitimacy of democratically accountable design decisions. The government hope that DAS will make the process and outcome of decision making more open, rigorous and sustainable.

This paper seeks to briefly chart the background to government intervention in design decision making through planning. It then specifically investigates whether DAS are in fact perceived as improving decision making from the local planning authority perspective, as well as the developer perspective, using primary data from NE England. Comparisons are made with a recent national study by the Planning Advisory Service on DAS. This reveals different viewpoints on the extent to which the introduction of DAS is helping the design decision making process. Developers are more critical than LPAs, but all perceive some value in the process and offer views on potential improvements.

Keywords: design and access, design assessment, government intervention in design, planning applications, sustainable design, urban planning, sustainable development

Introduction

The planning application process, a key element of urban planning, covers many issues and design assessment is one issue currently attracting much attention. The nature of design assessment in the planning process, and the outcome of such assessment, directly affects quality of life in terms of urban environment.

There are various tools available to assist planners with design decision making including national and local design guides. These guides are useful but their purpose is largely to set out design criteria that may be acceptable to planners. Recent focus has been on how applicants can better convey their design concepts to planners.

One recent tool conceived to better enable applicants to convey the development of the design of their scheme is the Design and Access Statement (DAS). DAS was introduced as a legal requirement in 2006, through amendments to the General Permitted Development Order 1995, and pursuant to the Planning and Compulsory Purchase Act 2004. The government released Circular 1/2006: guidance on the changes to the development control system (DCLG, 2006) that describes the changes.

A DAS is an explanation by the applicant making a planning application of the design process behind the submission. The intention of the government is that DAS will improve the quality of development through assisting with better negotiation on design issues between planners and applicants and hence better planning decision making. All applications require a DAS except for changes of use, householder applications outside Conservation Areas and other designated areas, and engineering and mining operations. Although there is no statutory minimum information specified a DAS must cover the following:

- The proposed uses
- Amount of development
- Layout and scale
- Landscaping and appearance with reference to context
- Access and safety issues, with reference to relevant law.

Most of this information has been submitted with most planning applications for some time, but not in a systematic way, or in such a way that requires the applicant to justify the design and access elements.

The history of government intervention in design quality of development: relevant literature

The requirement for DAS follows from Planning Policy Statement (PPS) 1: Delivering Sustainable Development (ODPM, 2005). PPS1 encourages local planning authorities (LPA) to ensure good quality design as part of a sustainable environment. In recent years the government has gradually become more positive about LPA intervention in design. This is probably due in part to the increasing emphasis on sustainable development generally, and also in part due to the influence of the Commission for Architecture and the Built Environment (CABE) set up in 1999.

The degree of government intervention in design through the planning service has always been controversial however. Since the 1947 Planning Act the role of planning in design control has been much criticised, especially during the 1960's with much high rise development being unpopular and unsympathetic to historic townscape. A key government response to the criticism at that time was to introduce the Civic Amenities Act in 1967 that allowed for Conservation Areas to be designated. Particular care was to be taken by planners regarding design of new development in Conservation Areas. Subsequent legislation has reinforced the importance of good design in Conservation Areas including the latest conservation act, The Planning (Listed Buildings and Conservation Areas) Act 1990. This act, and the related Planning Policy Guidance (PPG 15) on Planning and the Historic Environment (DoE, 1994), require all new development or alterations to existing development to "preserve or enhance the quality or appearance of the area". The focus on good quality design in Conservation Areas may, however, have been at the expense of other areas. It is significant that DAS are required for nearly all applications, although for householder applications outside Conservation Areas and other designated areas they are not required. So through DAS the government is still sending the message that Conservation Areas are more important, albeit in the case of DAS only where minor development is concerned.

The development industry and their agents, including architects, have been particularly critical of the role of planning intervention in design. The accusation that too much interference by planners in design causes delays in development decisions, and even loss of jobs, hit a chord with Margaret Thatcher when she was prime minister in the 1980's. This was in line with much Conservative Party philosophy of minimal government intervention generally, and failure to fully recognise the importance of planning intervention on behalf of the public as a democratic asset. In 1980 she introduced Circular 22/80 on Development Control that actively discouraged planners from intervening in design matters. This resulted in LPA's having a light touch on design intervention and being reluctant to refuse bad design as design reasons for refusal were often not supported by inspectors at appeal.

It was not until the 1990's when John Gummer, part of the Thatcher and then Major governments, became prominent on design issues and introduced documents such Quality in Town and Country (1994) that the implications of a low intervention approach were exposed as detrimental for environmental quality. The hard line of Conservative philosophy appeared to be waning by then. In 1992 the Audit Commission produced "Building in Quality" and for the first time suggested trying to measure quality of outcome, including design, as a balance to the predominant measures of the planning service based on speed of decision making. There is still much debate about how to measure quality (in terms of both outcome and process), but the fact that it is recognised as an important aspect to attempt to measure signifies that quality of development is a key priority. The introduction of DAS may even have the potential to help with measurement of quality of process if information on how DAS was used is recorded.

Literature by CABE as background to promotion of DAS

Since 2000 CABE has produced a considerable body of literature advocating a positive role for planning in design matters. "By Design" (CABE/DETR, 2000) is one of the most detailed design guidance documents ever produced at government level. It is fully illustrated and uses much of the urban design language and concepts developed by key authors on the subject over the past few decades, including Cullen (1961), Lynch (1971) and Bentley et al (1985). This guidance clearly indicates that a very detailed consideration of design issues within planning decision making is appropriate, and to be encouraged.

Between 2001 and 2007 CABE produced many documents relating good quality design to increased financial value of development, especially in the longer term. This has particular relevance for the development industry. Developers tend to question the importance of quality design and are mainly concerned with short term profit, but perhaps some of the CABE literature may eventually help to change the culture of the development industry in this respect.

Another approach by CABE to increase the importance of design issues in planning, and create greater certainty at an earlier stage, is to promote Design Coding for large developments. Design Codes are drawn up before a planning application is made by the developer, with public involvement, so that a systematic and joined up approach to design principles is taken at the outset. Design Codes have not yet been used widely in the UK as yet, but they appear to help create a more certain, coherent and holistic design approach especially for large housing developments according to CABE's summary study of a Coding pilot study in England "Design Coding – Testing its use in England" (CABE, 2005). Following from Design Coding CABE's next major drive, alongside DAS, was to formulate the "Building for Life" criteria (CABE, 2008). "Building for Life" criteria are intended to be used by LPA's and the development industry to assess the longer term sustainability of design of new housing development.

Given the progression of CABE's literature topics with a focus on promoting good quality design within a more systematic decision making process, the promotion of DAS was a logical step. In 2006 CABE's published "Design and Access Statements: How to Write, Read and Use Them" as a supplementary guide to the government circular 1/2006 (ODPM, 2006).

Assessing the use of DAS

There has been some concern that DAS is just another hurdle for developers and causes unnecessary delay, especially at the validation stage of a planning application, but recent case law suggests the Planning Inspectorate will not bow to pressure from the development industry on delay concerns and is taking DAS seriously. The most publicised case is Filton near Bristol (2007). A DAS was submitted with a mixed use scheme by Bovis Homes and an appeal against refusal of the scheme was dismissed partly on design grounds and inadequacies in the DAS. Such inadequacies included lack of evidence that the design would be high quality and respect local character, lack of detail on location and scale and a lack of consistency with the design code for the scheme (Ricketts, S, 2007).

There are also concerns that any advantages of having a fuller explanation of the design process with the planning application makes little difference to the outcome of planning decisions (Planning Advisory Service, 2008). Together with the Planning Officers Society and CABE, the government funded, but independent, Planning Advisory Service (PAS) carried out a study to investigate such concerns. They reported in January 2008 with "Design and Access Statements - report from a learning group comprising 16 Local Planning Authorities".

The LPA's in the learning group represented both a geographical spread and a range of local authority types. It should be noted that only one NE authority was represented (South Tyneside), hence the NE region was under-represented overall in this study as most regions would have had two representatives. The learning group, akin to a focus group, involved development control and urban design officers, as well as occasional experts such as an access officer, building control officer or architect. The group met six times to share experiences, plus some follow up interviews were carried out with staff from four of the authorities. The main conclusion was that DAS can be an effective tool to improve the quality of a development and that DAS are particularly helpful in explaining a proposal to a Planning Committee.

A number of problematic areas were identified however:

- The quality of the statements themselves were sometimes poor and there is no consistent method for validating an acceptable statement
- The access information required at the planning stage versus the building control stage has become less clear
- The DAS requirement may cover too many small proposals
- statements can be too descriptive and not used pro-actively enough especially at pre-application stage
- There is insufficient evidence that ideas in DAS become translated into amended schemes or planning conditions
- The absence of sustainability issues in DAS and that without planning staff well trained in design issues the DAS may have little effect.

The main recommendations from the PAS suggested reducing the requirement for DAS by confining them to major applications and clarifying what constitutes an acceptable DAS. Also to get DAS to be used more pro-actively, which may mean better design training for staff, more use of DAS in pre-application discussions and clear reference to the DAS in conditions. The idea that "explicit reference be made to sustainability as one of the design considerations" was left without expanding on the practicality of this. Sustainability is not defined here and there must be a danger that this recommendation might make the DAS process more unwieldy and less well defined, especially in relation to other processes within planning decision making such as sustainability statements or Environmental Impact Assessment.

Study of DAS use in NE England: method

An in depth study of DAS in just one region of England, with both the LPA side and developer side involved, to help reduce bias, was considered a useful complement to the PAS study. The intention was both to confirm or otherwise the PAS findings (triangulate or corroborate to some degree) and to produce more detail to build up possible recommendations. It was also considered advisable to include a more representative sample of users of DAS including the developer side. The PAS study did not include the developer side, but did identify a number of useful points as a means to modify DAS based on LPA views. Further in depth studies in other regions of England would provide better data still, especially a region where the property market differs, and hence the negotiating power of the LPA on issues such as design may also vary. However the study of other regions was outside the scope of this paper.

Telephone interviews using semi structured questions, having been e mailed to respondents prior to the interview, were used to gather data. The semi structured questions were focussed but open, to enable in depth opinion based data to be gathered. The questions were wide ranging covering the current and possible future uses of DAS.

The sample for interview was based on one representative from each of 13 LPA's in the NE (either development control or urban design staff) and also one developer regularly operating in each of those authority areas. Mostly the same questions were asked of the LPA's and developers but some questions were only appropriate for the LPA, particularly those relating to how DAS was assessed. The category of "developers" included agents for developers, as well as developers themselves, but all of these were answering from a developer perspective

Analysis of the data was manual due to it's qualitative nature.

The questions asked covered the following:

Part 1 related to the perceived usefulness of DAS. The following topics were covered:

- Perception of the difficulties in assessing design quality and whether DAS has helped the process including negotiation
- The relationship between DAS and design policy
- The impetus that DAS may have on authorities to acquire improved design skills
- Whether DAS had made any difference to the number of amendments to design during the planning process, or the number of refusals of planning permission based on design reasons.

Part 2 related to how DAS are assessed by the LPA. The following topics were covered:

- who decides whether DAS contains adequate information
- which officers carry out the assessment of DAS
- whether the LPA have any criteria against which DAS are assessed.

Part 3 related to how DAS might be improved. The following topics were covered:

- whether it is helpful to have "design" and "access" put together
- whether a closer relationship between national design guidance and a DAS requiring developers to self assess against policy criteria might help
- whether submission of more contextual information rather than a DAS would help whether there should be a requirement to have a design professional submit a DAS whether DAS should only be required for major applications
- Interviewees were also asked if they had anything else to add on how to improve DAS

The Results and Analysis of the NE England study

Interviewees engaged well with the questions asked and provided some interesting data. One in particular (Sunderland City Council) provided examples of good or promising practice. As the data yielded was qualitative in nature a descriptive reporting and analysis follows rather than a quantitative exposition.

On the difficulties of assessing design quality in planning the LPA's mentioned defining "good design", balancing different issues, developers only wanting to "tweak" design, assessing wider context and understanding how the design developed, getting the appropriate level of detail, leaving too much for reserved matters and the difficulty of defending design refusals on appeal.

It is clear that DAS can potentially help to address most of these concerns but not the definition of "good design" and some only if LPA's use DAS more pro-actively than appears to be the case at present. Given the volume of recent literature, especially from CABE, relating to what is "good design" it is perhaps of concern that some LPA's are still having difficulty with this.

On the developer side some of the perceived problems were inevitably different. The personal preferences of planners and planners just following previous development were seen as problematic, as well as poor understanding of design by planners. Communication between planners and designers and, surprisingly, too many important issues being left to conditions was seen as unhelpful. It might have been expected that developers would be happier with conditions rather than taking more time to negotiate and amend before permission was granted. The almost universal use of Computer Aided Design (CAD) was also seen as presenting a difficulty when attempting to convey quality of design. Again DAS should be able to assist in addressing some of these problem areas.

When asked whether DAS has in fact helped, a significant majority said it had, with one elaborating to say that justifying design in DAS helps raise the basic standard, but one thought it helped only sometimes for major applications. In contrast developers generally considered DAS a waste of time with only one giving a qualified positive answer. One said pre-application discussions were preferable, with the implication that these were totally separate from DAS, but of course they should not be. DAS only becomes a legal requirement, however, at the point that the application is formally submitted. This raises the question of the timing of DAS submission – perhaps it should be earlier, at least in draft form.

On the question of whether DAS was more than just a formalisation of information already provided most LPA's said it did go beyond a mere formalisation, with one commenting that it helps speed up the process as there is now less need to ask for further information once the application is submitted. Developers, once again, were less positive, although one conceded that DAS did allow for reflection of the design process. One developer thought that DAS just amounted to doing the planners work for them.

Whether DAS has been an impetus for better design skills in LPA's resulted in most LPA's disagreeing that it had, and there was mixed views in LPA's as to whether DAS has resulted in more focus on design issues. Developers were not positive on this question and one commented that 3D images would be more helpful than DAS.

Despite the rather negative views in general on DAS from developers most appear to have engaged well with the process, at least the larger ones, according to the LPA's. Some smaller developers seem to find the process confusing. One developer view here is that DAS has made no difference in terms of engagement (but this may have been interpreted as engagement in design process with LPA's generally rather than DAS).

LPA's and developers consider that local and national design guidance is generally referred to in DAS, especially for larger schemes, but one pointed out that this does not necessarily mean that the guidance is adhered to.

On DAS and its use in negotiation on design a small majority of LPA's said DAS did not help. Several comments indicated potential here, however, with one saying DAS did help where the proposal was contrary to design guidance and another saying DAS would be more useful during negotiation at pre-application stage. Despite the fact that at present DAS is not required until an application is submitted Sunderland LPA said that a draft DAS was requested by that authority at pre-application stage. The Sunderland approach here appears to represent good practice.
Developers had mixed views on the negotiation question with a fairly even split of positive and negative views.

Amendments to design during the planning process and refusals on design grounds do not seem to have increased or decreased significantly since the introduction of DAS, according to both the LPA's and developers. This indicates that DAS does not appear to be being used to full potential, or, as indicted by one LPA respondent, that other tools such as design guides are really much more significant. Only one LPA thought that there were more amendments since DAS due to the thought process being more open.

On the validation and assessment of DAS most said a planning technician does the validation (ensuring that enough information is provided) but planning officers, either the development control case officer or the urban design officer actually assesses the DAS (considers its content in relation to the scheme submitted). CABE criteria and Circular 1/2006 are used to assess DAS by some LPA's, but two said no criteria were used and one (Sunderland) had its own supplementary planning guidance on DAS. Sunderland again appears to be ahead in terms of good practice here as local guidance is generally recognised to be helpful to both the LPA and developers, creating greater clarity and consistency within an authority.

As to the future of DAS, starting with whether it is desirable to have "design" and "access" together, most LPA's agreed it was, and one added especially regarding safety issues. Developers were less enthusiastic with one saying sometimes and another saying the access part is more useful at the building control stage. Certainly many access issues are dealt with at the building control stage, but there are many general access issues that require consideration at the planning stage, most obviously how pedestrians and vehicles will access a development and by what mode.

Having a requirement for developers to assess their scheme against policy in a DAS was favoured by the majority of LPA's, especially for large schemes, but not by developers. More contextual information with DAS was also favoured by the majority of LPA's, but developers considered they were already doing enough. Sunderland City Council is already asking for 3D Sketchup illustrations.

Whether a requirement that a design professional must submit DAS would help with quality of statements and outcome met with a majority of LPA's giving a qualified positive answer – for major applications, but hard to enforce. Developers were mixed on this with just half agreeing. Although some developers were represented by architects in this study there were few. It might be expected that a majority of architects would agree with a requirement for a design professional involvement.

In contrast to the results from the PAS (2008) study the majority of both LPA's and developers did not agree that DAS should be for major applications only. Three LPA's said that small applications can be just as influential as some large ones. One developer suggested that there should be a DAS with all contentious applications, whether large or small, and another developer wanted DAS abolished altogether.

Other information added by LPA's included reference to a more joined up approach on the topic of design. There has been a considerable amount of design guidance produced recently by various bodies, some of which has unclear status, to the extent not only developers are confused but also LPA's. Other comments include suggestions to remove DAS for all householder applications (currently DAS is required for householder applications in Conservation Areas and other designated areas), avoid a tick box approach and slim down the information required in DAS. Developers mainly just wanted clearer guidance on DAS with a formal minimum standard, although one thought it was too time consuming and only amounted to "padding". The downside of a formal minimum standard could be many DAS being drafted only to this minimum which may prevent excellence.

Conclusions

The NE study has produced some useful data, only some of which corroborates the PAS study. Both studies show that not all of the original intentions of Circular 1/2006 or the CABE guidance on DAS is being carried out, especially those relating to improving quality of outcomes. DAS has only been in operation for just over two years at the time of gathering the primary data for the NE study, and would only have been operational for just over one year when the data was gathered for the PAS study. These timescales are clearly a limitation for both studies, especially the PAS study, and it may be that with more time some of the problems may be addressed without any radical further intervention by central government.

One of the main recommendations from the PAS study was to require DAS for major applications only, but the NE study did not fully corroborate this point with the majority of LPA's and developers wanting to keep them for smaller applications as well, except for a minority saying all householder application should be removed from the DAS requirement. It is especially interesting that developers indicated appreciation of the impact of smaller development. Having said that, developers were fairly negative (more so that LPA's) about the way DAS was operating, indicating scope for improved practice. Without improved practice at local level the original intentions of central government and CABE to use DAS to help improve quality of outcome will not occur.

Improved practice might include LPA's producing local supplementary planning guidance on DAS, as Sunderland City Council has done. This could provide information on what level of detail is expected in DAS, who does what in terms of validation, use of DAS in negotiation to secure design amendments and how DAS may be linked to planning conditions. It would also seem desirable to have at least a draft DAS for pre-application meetings, as in Sunderland, although the PAS study suggests pre-application discussions should focus on design principles and rationale, using diagrams not DAS.

A significant point to arise from the PAS study was that sustainability criteria should be included in DAS due to the national importance of climate change. PAS states that this has implications for various aspects of design including orientation, layout, materials, form and window type. The use of the term sustainability did not arise explicitly in the NE study. Due to the increasingly wide interpretation of the concept it would seem difficult to build this further into DAS than it already is implicitly, without losing focus and possibly causing confusion with other aspects of the planning decision making process. As DAS already includes aspects such as layout and form it could be argued that sustainability is implicitly integrated at present.

Apart from the issues of DAS for major applications only, availability of (draft) DAS at pre-application stage and sustainability issues in DAS, the other key messages from the PAS study were either corroborated by, or did not contradict, the findings from the NE study. These other common key messages include the need for greater clarity on aspects of access, especially the level of information needed at the planning stage and then the building control stage. Also more active engagement including more use of DAS in negotiation and conditions, strong leadership on design issues together with a culture of design excellence in LPA's as well as in the development industry. The latter point, so fundamental to sustainable development, has been made in various CABE publications, by Carmona, M and Sieh, L (2005) and by Paterson, E (2006), but it is a complex task to implement although happening slowly. A culture change can only be effected over a period of time with multiple tools, one of which is DAS, as well as political will. As this happens it is hoped that one of CABE's (2008) mantra's "design should be good enough to approve, not bad enough to refuse" becomes mainstream thinking in LPA's. DAS could be a significant step towards this.

This paper has strong links to three of the conference themes:

a) Urban planning and design for sustainability - in that DAS are intended to improve communication between key players in delivering sustainable design through planning

b) Quality of life in the urban environment - in that DAS aim to help to secure improvements to the design of the finished development, so enhancing quality of the environment

c) Measures, assessment theory, complexity and uncertainty - in that DAS is intended to facilitate better informed assessment in a complex area of government intervention in the market. DAS should also help reduce uncertainty regarding developer intentions.

Bibliography

Audit Commission (1992) "Building in Quality: a Study of Development Control" HMSO, London

Bentley et al (1985) "Responsive Environments" Architectural Press, Oxford

CABE/DETR (2000) "By Design" HMSO, London

CABE (2005) "Design Coding: Testing its use in England" CABE, London

CABE (2006) "Design and Access Statements: How to Write, Read and Use Them" CABE, London

CABE (2008) "Building for Life: Criteria for Assessment of New Housing Development" CABE, London

Carmona, M and Sieh, L (2005) "Measuring Quality in Planning: Managing the Performance Process" Taylor and Francis, London

Cowan, R (2008) “Design and Access Statements Explained” Thomas Telford Ltd, London

Cullen, G (1971) “The Concise Townscape” Architectural Press, Oxford

DCLG (2006) Circular 1/2006 “Guidance on the Changes to the Development Control System” HMSO, London

DoE (1980) Circular 22/80 “Development Control – Policy and Practice” HMSO, London

DoE (1994) “Quality in Town and Country” HMSO, London

DoE (1994) PPG 15 “Planning and the Historic Environment” HMSO, London

Lynch, K (1961) “The Image of the City” MIT Press, Cambridge, Massachusetts

ODPM (2005) PPS 1 “Delivering Sustainable Development” HMSO, London

PAS (2008) “Design and Access Statements” Report from a Learning Group comprising 16 LPA’s. IDA, London

Paterson, E (2006) “Quality New Development in English Market Towns: Case Studies examining the role of Town Planning” Journal of Urban Design Vol 11, no 2 pp225-241

Ricketts, S (2007) “Advice on Design and Access Points to Potential Traps” Legal Report, Planning Resource, 12.10.07

List of acronyms

DAS (Design and Access Statements)
DCLG (Department of Communities and Local Government)
PPS (Planning Policy Statement)
DoE (Department of the Environment)
LPA (Local Planning Authority)
CABE (Commission for Architecture and the Built Environment)
PPG (Planning Policy Guidance)
ODPM (Office of the Deputy Prime Minister)
DETR (Department of the Environment, Transport and the Regions)
PAS (Planning Advisory Service)
CAD (Computer Aided Design)

Assessment of the embodied CO_2 in buildings towards a sustainable building design and construction

Adolf Acquaye, Dr Aidan Duffy

Dublin Institute of Technology, Ireland

Increasing population in urban cities and town means that new building and other social infrastructure needs to be constructed. Embodied CO_2eq emissions of new buildings should be used as one of the sustainable indicators to measure the whole life sustainability of buildings given that the embodied CO_2eq of a building becomes very significant especially as operational energy efficiency measures and standards are continually being improved. In this paper, a hybrid embodied carbon dioxide equivalent (CO_2eq) methodology used to assess the CO_2eq embodied in buildings is presented. The hybrid methodology consists of an Input-Output (I-O) and a process-based analysis. The I-O analysis is undertaken using re-derived Supply and Use and Input-Output data for Ireland which includes energy inputs into imported construction products and materials and construction sub-sectoral energy data. The Grand Canal Apartments in Dublin, Ireland is used as a case study. The buildings substructure, internal walls, floors, stairs, frame and roof was analysed in the study

The Irish construction sector is divided into five different sub-sectors, each with varying direct energy intensities and accounting for different construction activities. The construction sub-sectoral I-O direct energy intensities ranges from 25.61tCO_2eq/m€ for general fit-out to 493.27tCO_2eq/m€ for the use of construction machinery. The I-O indirect intensity averaged 347.67 tCO_2eq/m€. The total embodied CO_2eq of a Grand Canal apartment building was estimated to be 0.00718tCO_2eq/€. The use of construction sub-sectoral data in this study disaggregates the construction sector and ensures that CO_2eq intensities can be applied to specific activities which are undertaken in the construction of the building. Furthermore, disaggregation of the energy supply sectors in the I-O analysis eliminates non-energy inputs in the I-O analysis and ensures the use of specific energy tariffs and primary energy factors. By re-deriving the I-O tables to include energy inputs into imported goods and services, the whole life embodied CO_2eq of the building is assessed.

Energy saving efforts and sustainability initiatives in the construction sector such as considerations to embodied CO_2eq of building materials, selection and design options can play a significant role in reducing the overall future CO_2eq of the country. Reduction in the CO_2eq embodied in buildings helps to tackle environmental pollution but needs however to be balanced with economic and social costs in order to achieve an overall sustainable urban solution.

Keywords: Ireland, embodied $CO_2 eq$, hybrid assessment, sustainability, construction sector

1 Introduction

The construction industry typically consumes significant energy resources in an economy (Suzuki et al 1995). According to Perez-Lombard et al (2008) global contribution from buildings towards energy consumption has steadily increased reaching figures between 20% and 40% in developed countries. Consequently this causes substantially environmental emissions and environmental impacts and raises issues of sustainability (Cole 1998, Junnila et al 2003). In Ireland as in many other economies, the construction industry is very important economically but is also energy intensive. According to a report by the United Nations Economic Commission for Europe (UNECE 2006), Ireland had the highest level of construction activity between 2004 and 2007 although there has been a general slow down in the construction market locally and globally. By 2005 it contributed to 19% of GDP and 22% of GNP. This level of activity is likely to be associated with significant energy use and related emissions from the construction industry, raising questions about environmental sustainability.

The building and construction sector in Ireland consumed 25% of total primary energy consumption (Sustainable Energy Ireland 2007a). Hence to achieve security of supply, competitiveness and environmental sustainability as outlined in the Irish White Paper and the Irish Energy Policy Framework 2007-2020, energy use and emissions in the construction sector must be reduced. A starting point in reducing these emissions is to develop assessment techniques in energy intensive sectors such as building and construction so that emissions can be quantified and policy effectiveness assessed. Such steps will deliver a sustainable building design and energy future for Ireland and fulfil national and European Union (EU) climate change targets under the Kyoto protocol. Furthermore, as companies seek to obtain ISO 14000 environmental management accreditations, such assessment techniques and analysis would provide an effective way of quantifying and managing their environmental impacts.

Lack of environmental initiatives and research studies targeted at the Irish construction sector (Forum for the Construction Industry 2003, UCD Energy Research Group 2007) means that sustainable energy policy and regulatory measures are not fully incorporated with new environmental research knowledge to regulate whole life energy use in the building and construction sector. The aims of this paper will therefore;

- Present a systematic analysis in the quantification of embodied CO_{2eq} emissions resulting from the total energy used in the construction of buildings.
- Estimate the embodied CO_{2eq} of an apartment building in Dublin, Ireland
- Identify the sources and where the emissions arise

Construction sector emissions intensities of three gases: CO_2, N_2O and CH_4 are analysed. These emissions are analysed because they are the major environmental emissions associated with energy use in the construction sector. CO_{2eq} emissions arise from the consumption of fossil-fuel derived electricity and the use of fuel such as diesel in plant and machinery. Impact assessment can aggregate CO_2, methane and other greenhouse gas emissions (GHG) into a single impact assessment parameter affecting climate change or global warming. CO_2 equivalent weighting known as global warming potential (GWP) is ascribed to each greenhouse gas which is then summed to give a total CO_{2eq}. Carbon dioxide equivalent, CO_{2eq} provides a universal standard of measurement against which releasing different green house gases can be evaluated as an impact of global warming (International Emissions Trading Association 2008). The six greenhouse gases, GHG specified in the Kyoto Protocol are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Of these, naturally occurring energy related GHG released into the atmosphere are CO_2, N_2O and CH_4

2 Methodological Assessment

A hybrid assessment used to calculate the embodied CO_{2eq} intensity of a building is presented. The hybrid assessment combines input-output (I-O) analysis at a construction sector and sub-sectoral level and process analysis inventory.

2.1 Process Analysis

Process analysis is usually undertaken at an industrial level by measuring the inputs and outputs of energy and materials flow during the manufacturing processes of a product. The sum of all the energy used directly and indirectly during the manufacture of the product per unit output of the product is the process energy intensity for that particular product. In process analysis all the infinite energy inputs that go into the production of a product cannot be accounted for. According to Born (1996), process analysis suffers from truncation due to the setting of system boundaries but can be combined with I-O analysis into a hybrid model which has the advantages of the more accurate process analysis data and an I-O framework more complete in system boundary (Suh et al 2002, Mongelli et al 2005). The process analysis intensity in this study is calculated using database of inventory of carbon and energy, ICE v1.6 published by Sustainable Energy Research Team (2008).

2.2 Input-Output Analysis

Embodied energy and CO_{2eq} I-O analysis is undertaken using national economic data whereby energy intensities are determined per unit monetary value of output. The energy and CO_{2eq} associated with activities in the building and construction sector can be characterized as direct and indirect and evaluated using I-O analysis. The former released directly due to activities undertaken on the construction site (for example structural works, fit-out, plant operation). Indirect emissions are associated with the upstream use of energy in construction-related activities (for example energy used to manufacture building materials, excavation of raw aggregate, design team activities). In this paper, the total I-O CO_{2eq} intensity is calculated as a sum of direct CO_{2eq} intensity derived from construction sub-sector energy use data and I-O indirect CO_{2eq} intensity calculated using national I-O tables.

2.2.1 Direct CO_{2eq} Intensity

The I-O based direct energy intensity of construction is determined at a sub-sector level rather than at the aggregated sectoral level to improve accuracy. The direct emissions intensity is calculated from construction company data collected by the Irish Central Statistics Office in a census which categorizes energy use according to five construction sub-sectors (Central Statistics Office 2007). The data collected was categorized into electricity and fuel used on site. It is assumed that fuel used was diesel since vast majority of plant and construction machinery uses operates on diesel fuel (Central Statistics Office 2007 and Limerick Energy 2008).

A representative sample of 728 Irish construction firms was surveyed in a 2005 census and the electricity and fuel consumption of each was recorded. The primary energy in each construction sub-sector (Sub-Sector 1 to Sub-Sector 5) was derived from this. The CO_{2eq} intensities in tCO_{2eq}/€ was then derived for each Euro output of each sub-sector using Irish emission factors.

Irish electricity emission factors are derived taking into account the fuel type used in electricity generation and efficiencies of each generating plant. The electricity used in each construction sub-sector was therefore derived from each fuel type using the ratios of electricity generation mix in Ireland. The environmental emissions intensities (CO_2, N_2O, CH_4) due to electricity used on site was then calculated for each fuel type. Diesel emissions were also calculated using diesel emission factors and added to electricity emissions. The direct CO2eq intensity for the construction sector was then determined using the Global Warming Potential (GWP) of each gas and summing all CO_{2eqs}.

The construction sector in Ireland is divided into five sub-sectors namely: Sub-Sector 1 to Sub-Sector 5. Descriptions of the construction processes and activities undertaken in each sub-sector are outlined below;

Sub-Sector 1: Site preparation, demolition of buildings, earth moving, ground work, drilling and boring, etc

Sub-Sector 2: Building of complete constructions or part thereof; civil and structural construction works, etc

Sub-Sector 3: Building installation, installation of electrical wiring and fittings, insulation, plumbing and other installations, etc

Sub-Sector 4: Building completion, joinery installation, plastering, floor and wall, covering, painting, glazing and general fit-out, etc

Sub-Sector 5: Construction plants and equipments, etc

Because different construction activities are undertaken in each of the sub-sectors, their energy intensities will also vary. These represent the direct emissions intensity since these emissions are calculated using data on energy consumed on the construction site. According to Bullard et al (1978) and Tiwari (2000) the calculated I-O direct and total energy intensity of different but similar products such as a building belonging to the same I-O economic sector will be the same even though the production or construction processes undertaken in each is different. This hybrid analysis tackles this problem in traditional I-O analysis. When the I-O based direct CO_{2eq} intensity is calculated, it produces a unique direct CO_{2eq} of the building and consequently a unique total CO_{2eq} intensity for every building.

2.2.2 Indirect Emissions Analysis

Indirect emissions intensities in the construction sector are estimated using data from the National Input-Output (I-O) tables. These are generated using data from the national accounts as well as other sources to show the economic transactions between all product sectors of the national economy. The input coefficients of the economy wide I-O tables are used to derive indirect energy and CO_{2eq} intensities in the building and construction sector. Because of the extended system boundary of I-O analysis, upstream energy inputs missed the process analysis are captured.

The I-O intensities are calculated as GJ of energy consumed or tCO_{2eq} of CO_2 emitted per Euro output of the building and construction sector. The national I-O tables consist of supply and use tables together with symmetric input-output tables.

The indirect emissions intensities were evaluated as the difference between the I-O total and I-O direct emissions intensity as described by Treloar (1998). According to Bullard et al (1978), Lenzen et al (2000) and Stromman et al (2008) the total energy intensity is derived from the Leontief Inverse Matrix, $(I-A)^{-1}$ which is a binomial expansion estimate of the total deliveries or the sum of the zero order delivery to the infinite order delivery from one product sector of the economy to another.

Hence

$$\text{Leontief Inverse Matrix} = A^0 + A^1 + A^2 + A^3 + \ldots$$
$$= I + A^1 + A^2 + A^3 + \ldots$$
$$= (I-A)^{-1}$$

Where:

A= Matrix of direct requirement coefficients which shows the direct delivery from one product sector of the economy to another

This is employed using national I-O tables (Central Statistics Office 2006), average energy tariffs for Ireland (International Energy Agency, 2006) and primary energy factors (Sustainable Energy Ireland, 2006) and disaggregation factors (Wissema 2006) to determine energy intensities per unit monetary value of output from the construction sector.

Two further key features are incorporated into this methodology in order to improve its accuracy of calculated results from the available Irish data. These are:

- The addition of upstream energy inputs for imported goods and services and
- Disaggregation of the input-output energy supply sectors.

1. Energy Inputs of Imported Goods and Services

The main advantage of input-output analysis in energy and environmental research studies relates to the extended system boundary that the analysis offers over process-based approaches (Born 1996, Hayami et al 1997, Lenzen et al 2000). This is because in process analysis, because all the infinite energy inputs into a product can not be measured, a system boundary has to be set thus truncating some of the energy inputs. The direct requirement coefficient matrix of the Irish I-O tables used to evaluate the direct energy intensity and the Leontief inverse matrix used to calculate the total energy intensity (Treloar, 1998) is tabulated for domestic product flows. Hence, energy input into imported products has been omitted. EuroStat (2002) affirms this methodology by also stating that, if input-output tables are to be used to calculate the total energy intensity used to produce one unit of a particular product in an I-O analysis then the energy used to produce imported inputs should also be included. This is particularly important given that Ireland and its construction sector is heavily dependent on imported products (SCCI 2006). The methodology used to incorporate imported goods and services into the I-O tables is outlined in the European System of Accounts I-O Manual published by Eurostat (2002).

2. Disaggregation of Energy Supply Sectors

A limitation with I-O analysis is the aggregation of different products into one sector in the national I-O tables (Mongelli et al 2005). To tackle this problem, a constant called a "disaggregation constant", is incorporated into the input-output analysis in order disaggregate the energy supply sectors because the energy supply sectors are aggregated together either with non-energy supply sectors or other energy supply sectors. A detailed analysis of the disaggregation of the energy supply sectors in Ireland was first undertaken by Wissema (2006) in a study to construct a Social Accounting Matrix for Ireland. The Irish I-O table consists of three aggregated energy supply sectors namely:

- Mining and Quarrying Products;
- Petroleum and Other Manufacturing Products; and
- Electricity and Gas

The energy sector peat, crude oil and coal are aggregated together with other quarrying products. The second energy sector, oil is aggregated together with 'other manufacturing products' while the third energy supply sector "electricity and gas" consists of electricity, natural gas and renewable energy.

The use of the disaggregation constants has a two-fold advantage. Firstly, non-energy supply sectors are eliminated from the analysis. Secondly, it enables individual primary energy factors and energy tariffs to be used instead of average values for two or more aggregated sector energy supply sectors (example electricity and gas).

2.3 Hybrid Embodied CO_{2eq} Assessment

The assessment of the hybrid embodied CO_{2eq} analysis is as follows;

- The bill of quantities of the building is analysed and the quantities of the main building materials identified. The CO_{2eq} [tCO_{2eq}] of the main building materials are calculated using process analysis from the database of inventory of carbon and energy, ICE v1.6a (Sustainable Energy Research Team 2008).
- The CO_{2eq} of the rest of the entries in the bill of quantities of the building besides the main building materials which describes construction processes and activities are calculated using direct sub-sectoral CO_{2eq} intensities and I-O indirect CO_{2eq} intensities. The total expenditure on all itemised construction processes undertaken are grouped under one of the five construction sub-sectors outlined.

The direct sub-sectoral I-O part of the hybrid analysis is determined as follows.

- The primary energy intensity [GJ/€] representing direct energy use in each construction sub-sector (Sub-Sector 1 to Sub-Sector 5) was derived from the 2005 Irish construction census data
- The direct sub-sectoral CO_{2eq} intensity [tCO_{2eq}/€] was consequently calculated for each sub-sector using Irish emission factors published by Sustainable Energy Ireland (2007b) and global warming potential of the energy related greenhouse gases. The direct sub-sectoral CO_{2eq} intensity is calculated per Euro output of each sub-sector.

- The direct sub-sectoral CO_{2eq} [t CO_{2eq}] of the building is calculated from:

$$\text{Direct Sub - Sectoral CO}_{2eq} = \sum_{j=1}^{5} I_j E_j$$

Where:

j = Sub-sector

I = Direct sub-sectoral CO2eq intensity [tCO_{2eq}/€]

E = Output of each sub-sector for the building [€]

The indirect i-O part of the hybrid analysis is determined as follows.

- The direct requirement matrix and the Leontief Inverse Matrix were re-derived to include imported goods and services according to the methodology outlined by the European System of Accounts (EuroStat 2002). Further upstream energy inputs into building and construction products are included in the analysis as a result of this.
- The I-O direct and total energy intensities [GJ/€] of construction was calculated using the primary energy factors (Sustainable Energy Ireland, 2006), energy tariffs (International Energy Agency, 2006) and direct requirement coefficient and total requirement coefficient respectively (Central Statistics Office, 2006) as described by Treloar (1998).
- The direct and total I-O energy intensities of the overall construction sector were readjusted using disaggregation factors derived for Ireland by Wissema (2006)
- The I-O indirect energy intensities are calculated as a difference between the I-O total and the I-O direct energy intensities of the whole construction sector. The I-O indirect CO_{2eq} intensity was then derived for the whole Irish construction sector using Irish emission factors published by Sustainable Energy Ireland (2007b) and Global Warming Potential of the energy related greenhouse gases.
-

The indirect I-O CO_{2eq} [tCO_{2eq}] of the building is calculated from:

$$\text{I - O Indirect CO}_{2eq} = I_{(I-O)} \times \sum_{j=1}^{5} E_j$$

Where: $I_{(I\text{-}O)}$ = I-O Indirect CO_{2eq} intensity

- The hybrid CO_{2eq} intensity is evaluated as the ratio of the sum of the process CO_{2eq}, the direct sub-sectoral CO_{2eq} and the I-O indirect CO_{2eq} to the total expenditure of the building.

3 Results and Analysis

3.1 Direct Sub-Sectoral embodied CO_{2eq} of Building

Figure 1 show the quantities of electricity used by the sample of Irish construction companies classified by sub-sector in GJ of primary energy. By using the ratios of the electricity generating mix in Ireland: coal-25%, oil-13%, peat-9%, natural gas-46% and renewable energy-7%, the total amount of electricity by fuel type was calculated.

Figure 1: Direct Sub-Sectoral Analysis: Equivalent Electricity used in GJ split into fuel sources

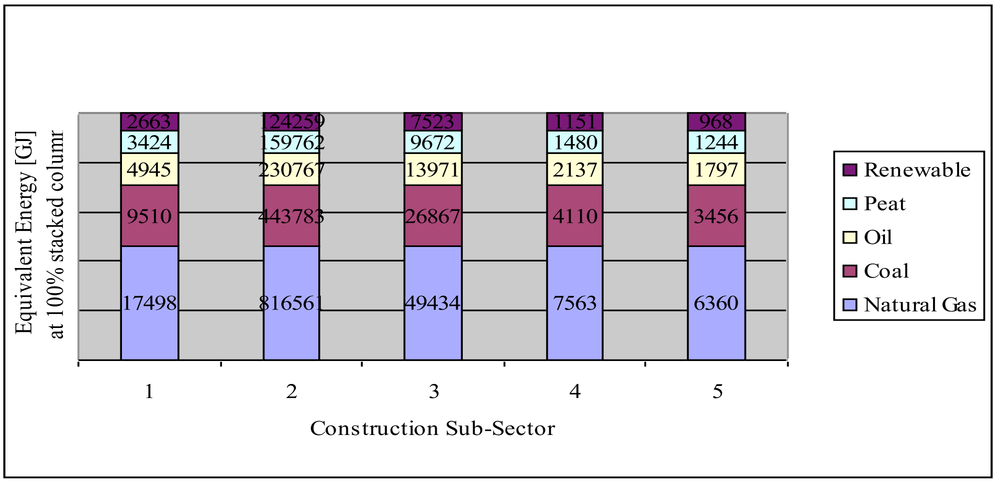
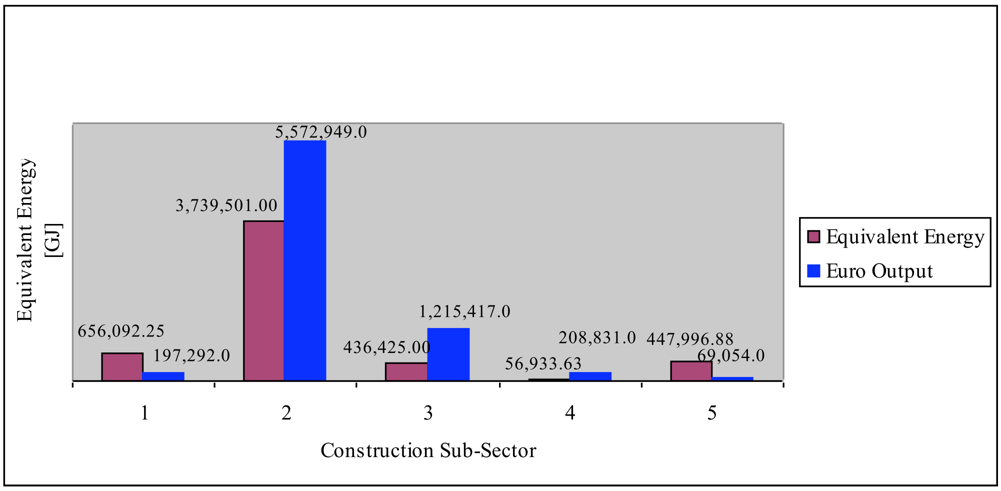


Figure 2: Direct Sub-Sectoral Analysis: Equivalent Fuel consumption in GJ and economic output of each sub-sector in Euros



Derived from: Central Statistics Office (2007)

Table 1: Electricity and Diesel emission factors in tonnes/GJ taking account of generating efficiencies

Electricity & Fuel	Gen. Eff. (η)	Fuel Mix Ratio	CO_2 [t/GJ] x 10^{-6}	N_2O [t/GJ] x 10^{-6}	CH_4 [t/GJ] x 10^{-6}
Electricity:					
Coal	0.370	0.25	88418.60	2.11	1.50
Oil	0.380	0.13	78500.00	2.00	3.00
Peat	0.385	0.09	105949.30	1.83	1.56
Natural Gas	0.414	0.46	55196.40	0.69	2.50
Renewable	1.000	0.07	0.00	0.00	0.00
Diesel	-	-	73300.00	1.77	3.95

Source: Sustainable Energy Ireland (2007)

The emissions intensity [t/GJ] presented in table 1 are multiplied by the quantities of electricity and diesel used [GJ] in each construction sub-sector and divided by the output of each sub-sector [€] to determine the direct emissions intensity for each sub-sector; these are presented in Table 2.

Table 2: The direct emissions intensities by construction sub-sector

Emission [t/m€]	Sub-Sector 1 (Ground Works, etc)	Sub-Sector 2 (Structural Work, etc)	Sub-Sector 3 (Services, etc)	Sub-Sector 4 (Finishes and Fit-Out, etc)	Sub-Sector 5 (Plant and Equipment)
CO_2	256.72	70.6	32.27	25.28	489
N_2O	0.006	0.002	0.001	0.001	0.012
CH_4	0.014	0.003	0.002	0.001	0.026
CO_{2eq}	258.87	71.28	32.62	25.61	493.27
Expenditure	29,324.30	2,019,047.33	487.80	177,640.67	14,655.68

Using:

$$\text{Direct Sub - Sectoral } CO_{2eq} = \sum_{j=1}^{5} I_j E_j$$

The direct sub-sectoral CO_{2eq} is estimated to be to be 163.3tCO_{2eq}

3.2 Indirect I-O embodied CO_{2eq} of Building

The primary energy factors (Sustainable Energy Ireland 2006), average energy tariffs (International Energy Agency, 1998) are presented in Table 3, the disaggregation constants in Table 4. Together with the re-derived direct requirement coefficients and the Leontief inverse coefficients of the 2000 National Supply and Use and Input-Output Table in Figures 5 and 6 (Central Statistics Office, 2006) the direct and total energy intensity of construction was calculated as described by Treloar (1998).

Table 3: Primary Energy Factors, Average energy Tariffs and Emission Factors for Ireland.

Energy Supply Sector	Primary Energy Factor	Average Energy Tariff [GJ/€]
Peat	1.01	0.1124
Crude Oil	1.00	0.5055
Coal	1.00	0.3681
Petroleum	1.01	0.1507
Natural Gas	1.03	0.2270
Electricity	1.11	0.0337
Renewable Energy	1.00	0.0686

Source (Sustainable Energy Ireland, 2006 and IEA, 2006)

Table 4: Disaggregation Constant of Energy Sectors for Ireland.

I-O Sector	Aggregated Energy Supply Sectors	Disaggregated Energy Supply Sectors	Disaggregated Constants
10-14	Mining and Quarrying	Peat	0.136
		Crude Oil	0.175
		Coal	0.116
23 & 36	Petroleum and 'Other Manufacturing'	Petroleum	0.700
40	Electricity and Gas	Electricity	0.755
		Natural Gas	0.205
		Renewable Energy	0.040

Source: (Wissema, 2006)

Figure 3: Comparison between the direct requirement coefficients of the construction sector to the energy supply sectors with and without imports

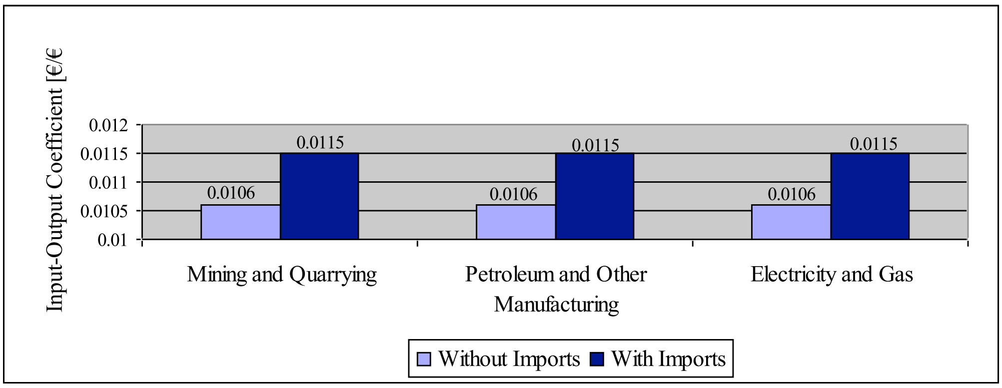
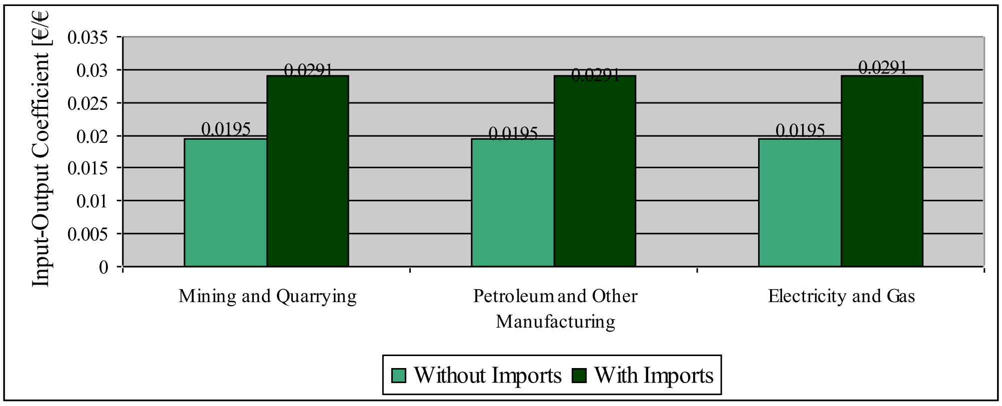


Figure 4: Comparison between the total requirement (Leontief) coefficients of the construction sector to the energy supply sectors with and without imports



The direct and total energy intensities of the Irish construction sector for each of the energy supply sectors are shown in Table 5. The direct and total energy intensities were found to be 0.00872 GJ/€ and 0.00373 GJ/€ respectively. Hence the I-O indirect energy intensity is estimated to be 0.00499 GJ/€.

Table 5: Direct, Total and Indirect I-O Energy Intensity of Irish Construction

Disaggregated Energy Sector	Direct Energy Intensity [GJ/€]	Total Energy Intensity [GJ/€]	Indirect Energy Intensity [GJ/€]
Peat	0.00018	0.00045	0.00027
Crude Oil	0.00102	0.00257	0.00156
Coal	0.00049	0.00124	0.00075
Petroleum	0.00086	0.00170	0.00084
Electricity	0.00027	0.00062	0.00036
Natural Gas	0.00046	0.00106	0.00060
Renewable Energy	0.00003	0.00006	0.00003

The indirect energy intensities presented in Table 5 is multiplied by the emissions intensities in Table 1 to obtain the indirect emissions intensities of energy use in the Irish construction sector.

Table 6: I-O indirect emissions intensity of the Irish construction sector

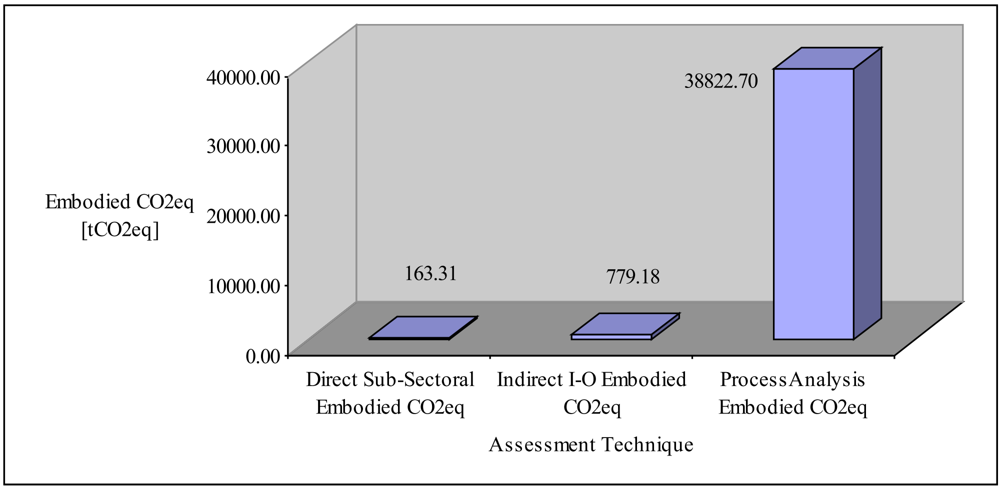
Energy Sector	CO_2 [t/m€]	N_2O [t/m€]	CH_4 [t/m€]	CO_{2eq} [t/m€]
Peat	28.7897	0.0005	0.0004	28.95
Crude Oil	122.2198	0.0031	0.0047	123.28
Coal	66.4477	0.0016	0.0011	66.97
Petroleum	66.0738	0.0017	0.0025	66.65
Electricity	28.1261	0.0006	0.0007	28.33
Natural Gas	33.3348	0.0004	0.0015	33.49
Renewable-Energy	0.0000	0.0000	0.0000	0.00
Total Indirect Emissions	344.9920	0.0079	0.0109	347.67

From:

$$\text{I - O Indirect CO}_{2eq} = I_{(I-O)} \times \sum_{j=1}^{5} E_j$$

The I-O indirect CO2eq is estimated to be 779.2tCO_{2eq}.

Figure 5: CO_{2eq} of apartment building split into assessment technique



The hybrid CO_{2eq} intensity of a Grand Canal Apartment buildings are estimated to be 0.00718tCO_{2eq}/€ given that the total cost of the apartments was built at a cost of €5,536,402.60.

4 Discussions

With significant efforts been made to achieve very high efficiency with energy use in buildings, the energy and CO_{2eq} embodied in building becomes increasingly significant and the proportion of embodied energy to operational energy keep increasing. According to Yohanis et al (2002) initial energy embodied in a building can be as much as 67% of the operational energy over a 25 year period. The Commonwealth Scientific and Industrial Research Organisation, CSIRO (2006) also states that embodied energy approaches half the lifetime energy consumption in very energy efficient home. As cities expand and new urban centres spring up new buildings has to be built to accommodate growing population and services but its energy consumption has to be regulated. The New Building Regulation introduced in Ireland is one such newly legislation passed to improve energy efficiency of buildings in Ireland. While such an effort is commendable, a holistic approach has to be taken by not focussing solely on operational energy in order to achieve whole life sustainability. Hence embodied CO_{2eq} of buildings should be considered and used as a benchmark or sustainable indicator in regulatory measures. The 2007 Energy White Paper for Ireland which sets out the energy policy framework for Ireland from 2007 to 2020 reported the need to reduce total energy consumption by optimizing energy efficiency, reducing operational energy use but failed to directly point out the significant energy reductions that can be achieved through considerations to embodied energy in Ireland. This is especially important given that embodied energy research has not been undertaken in Ireland as is the case in other countries in Europe, Australia, United States and Japan.

The hybrid analysis indicates that for every Euro spent on a Grand Canal Apartment building, 0.00718 tonnes of carbon dioxide equivalent is emitted into the atmosphere. In this hybrid CO_{2eq} analysis the total embodied CO_{2eq} of the building does not only consist of the CO_{2eq} embodied in the building materials. All construction activities undertaken are accounted for and their embodied CO_{2eq} estimated using direct I-O based sub-sectoral CO2eq intensities. The use of national I-O data also accounts for indirect and upstream energy inputs into the construction sector. The majority of embodied CO_{2eq} however is as the result of building materials such as steel, concrete, reinforced concrete, etc which have high embodied CO_{2eq}.

I-O indirect energy intensity from the re-derived I-O table which includes energy inputs into imported goods and services in the construction sector was estimated to be 0.00441 GJ/€. This is almost double the I-O indirect energy intensity of 0.00227 GJ/€ obtained using direct requirements coefficients and Leontief Coefficients with imports goods and services discounted. The use of re-derived I-O tables therefore shows that energy inputs into imported goods are very significant although such indirect energy inputs can be difficult to control or regulate in any national energy policy measure. It also provides greater information for decision making by designers and policy makers by considering total global impacts. Greater control of indirect energy inputs can however be achieved when energy policy is formulated and implemented at a regional context such as the EU level.

5 Conclusions

The research shows that such environmental analysis can be used to quantify the CO_{2eq} emissions associated with buildings in the construction sector. Such quantitative measurements can be used to inform policy and regulatory measures. Building and activities in the construction sector contributes significantly to total national CO_2 emissions. The sustainable challenges confronting the design of new buildings call for complete sustainability tools which can assess such buildings. In order to achieve whole life sustainability, embodied CO_{2eq} assessment must be incorporated to any such tool or metrics.

A hybrid embodied CO_{2eq} analysis combining process, input-output and sub-sectoral construction sector analysis provides a comprehensive approach in estimating the CO_{2eq} embodied in buildings. Energy saving and CO_{2eq} limiting efforts can be achieved through such an analysis by identifying alternative building materials with lower embodied CO_{2eq} and employing energy efficient initiatives in construction sub-sectors with high energy and CO_{2eq} intensities.

Further research in embodied CO_{2eq} of buildings can lead to the formulation of regulations and standards comparable to operational energy use of buildings. In such a case, buildings could also be rated according to the amount of CO_{2eq} it embodies.

6 Reference

Born, P (1996) Input-output analysis: input of energy, CO_2, and work to produce goods. 'Journal of Policy Modelling ', volume 18, issue 2, 217–221

Bullard, CW, Penner, PS, Pilati, DA (1978) Net Energy Analysis: Handbook for Combining Process and Input-Output Analysis, 'Resources and Energy' volume 1, 267-313

Central Statistics Office (2006) Supply and Use and Input-Output Tables, 'Published by the Stationary Office', Dublin, Ireland; ISSN 1649-5918, ISBN 0-7557-7134-606. 2006

Central Statistics Office, CSO (2007) 2005 Census of building and construction. ISSN: 1393-7103. Ref: 134/2007.

Cole, R, J (1998) Energy and greenhouse gas emissions associated with the construction of alternative structural systems, 'Building and Environment', volume 34, issue 3, 335-348

Commonwealth Scientific and Industrial Research Organisation, CSIRO (2006) Embodied Energy-Sustainable Built Environment, Available for download at http://www.cmmt.csiro.au/brochures/tech/embodied/#

EuroStat (2002) The ESA 95 Input-Output Manual – Compilation and Analysis –'European Commission' Version 2002

Forum for the Construction Industry (2003) Applied construction innovation centre initial feasibility study, Ireland

Hayami, H, Nakamura, M, Suga, M, Yoshioka, K (1997) Environmental Management in Japan: Applications of Input–Output Analysis to the Emission of Global Warming Gases, 'Managerial and Decision Economics' volume 18, 195–208

International Emissions Trading Association (2008) What are carbon dioxide equivalents (CO2eq)? 'Market Solutions for Global Environmental Problems'

International Energy Agency (2006) Detailed Energy Balance for Ireland

Junnila, S, Horvath, A (2003) Life-Cycle Environmental Effects of an Office Building, 'J. Infrastruct. Syst', volume 9, issue 4, 157-166

Lenzen, M, Dey, C (2000) Truncation error in embodied energy analyses of basic iron and steel products, 'Energy', volume 25, 577-585

Limerick Energy (2008) Renewable diesel-Gen 2, Available for download at http://www.limerickenergy.com/renewable/index.html

Mongelli, I, Suh, S, Huppes, G (2005) A structure comparison of two approaches to LCA inventory data, based on MIET and ETH databases, 'Int J LCA', volume 10, issue 5, 317-324

Strømman, AH, Solli, C (2008) Applying Leontief's Price Model to Estimate Missing Elements in Hybrid Life Cycle Inventories, 'Journal of Industrial Ecology' volume 12, issue 1, 26-33

Suh, S, Huppes, G (2002) Missing inventory estimation tool using extended input-output analysis, 'Int J LCA', volume 7, issue 3, 134-140

Sustainable Energy Ireland, SEI (2006) Energy Statistics for Ireland, 'Energy Policy Statistical Support Unit', Cork, Ireland

Sustainable Energy Ireland, SEI (2007a) Energy in Ireland 1990 – 2006 Report, 'Energy Policy Statistical Support Unit', Cork, Ireland

Sustainable Energy Ireland (2007b) Emissions Calculator-Ireland, version 5, 'Energy Policy Statistical Support Unit', Cork, Ireland

Sustainable Energy Research Team (2008) Inventory of carbon and Energy, ICE, version 1.6a,' University of Bath' United Kingdom

Suzuki, M, Oka, T, Okada, K. (1995) The estimation of energy consumption and CO2 emission due to housing construction in Japan, 'Energy and Buildings' volume 22, issue 2, 165-169

Swedish Chamber of Commerce Ireland, SCCI (2006) Spotlight Sweden, 'SCCI News' volume 7, 1-10

Tiwari, P (2000) An analysis of sectoral energy intensity in India, 'Energy Policy', volume 28, issue 11, 771-778

Treloar, GJ (1998) "A Comprehensive Embodied Energy Analysis Framework", PhD thesis, Deakin University, Australia

United Nations Economic Commission for Europe, UNECE (2006) Republic of Ireland-National Market Report 2006, 'Annual Meeting of Timber Committee' 3rd-4th October 2006.

University College Dublin, UCD, Energy Research Group (2007) Green Paper: Towards a Sustainable Energy Future for Ireland, 'Department of Communication, Energy and Natural Resource', Ireland

Wissema, W (2006) Building Social Accounting Matrix for Ireland with specific details in relation to energy and carbon dioxide emissions, 'Institute for International Integration Studies', Dublin- Ireland, Number 170, 1-28

Yohanis, YG, Norton, B (2002) Life-cycle operational and embodied energy for a generic single-storey office building in the UK, 'Energy', volume 27, issue 1, 77–79

6.1 Acknowledgement

The authors will like to thank Dr Patrick Quill of the Central Statistics Office in Dublin for his valuable advice on the Supply and Use and Input-Output Tables for Ireland. The assistance of Mark Cordy of Davis Langdon PKS is also well appreciated for his assistance in providing data on the case study.

Improving traditional ventilating systems for elaborated modern needs

Mojtaba Pourbakht, Prof. Akira Fujii
The University of Tokyo, Japan

Problem: Global warming and high expenses due to integrated use of electrical ventilating systems. Urban planning and design for sustainability involves taking into action reducing greenhouse gas emissions and to enhance practical methods for reducing the extent of global warming. This is to urge urban planners to minimize the effects of global warming.

Abstract: The Wind-Catcher and Solar Chimney are two of the ancient architectural elements that are suggested for the plan. The flow of water underneath is accessed as a natural cooling enterprise. The use of underground pools or connectivity of the ventilation system with a pipe to the nearest water flow is for cooling the gust of air. For each block of buildings a well is needed to access the underground water flow. Then by the use of some pipes they can all be connected to one another. Besides,for money saving issues the Wind-Catcher and the Solar Chimney can be operated by the same pipe.

A Wind-Catcher is capped and has several directional ports at the top. By closing all but the one facing away from the incoming wind, air is drawn upwards similar to how opening the one facing the wind would push air down the shaft. This generates significant cooling ventilation within the structure below, but is not enough to bring the temperature below ambient alone.

And a Solar chimney uses natural ventilation that can be created by providing vents in upper level of a building to allow warm air to rise by convection and escape to the outside. At the same time cooler air can be drawn in through vents at the lower level. Trees may be planted on that side of the building to provide shade for cooler outside air.

The heart of this paper is to help reduction of greenhouse gas emissions through reducing energy use and switching to cleaner energy sources. Through an integrated combination of Solar Chimney and Wind-Catcher will be an elaborative method to enhance the use of traditional ventilating solutions for the modern era. In an urban viewpoint, to have diversified strategies for different places in the city, notification of Zoning Policies seems vital. For Open spaces and Light Industrial Areas there is no demand for my proposal but in case of Commercial Spaces, Low & High Density Residential areas which form the majority of our spaces, this method can be vastly utilized. The result for reducing greenhouse gas emissions by this method will be awesome.

Keywords: Qanat, greenhouse gas, solar chimney, vernacular ventilation, wind catcher

1 Introduction:

Global warming, pollution and dwindling energy supplies have led to a new environmental approach in building design. Innovative technologies having bioclimatic principles integrated in traditional design strategies can possibly merge to create new and potentially successful design solutions. For times it has been the topic for many researchers to list out the most vital factors in people's urban life. They did great effort to get a way into an ideal realm in industry to bring about comfort for all people with the lowest rate of energy consumption. This very egregious achievement however will not anymore be considered as impossible. For times it might have been a laboratory fiasco to make an optimum use of energy in contemporary buildings but we can hopefully claim it will be feasible.

An efficient use of energy in modern buildings is highly awarded in a modern society. To enhance the implication of some scientific tactics to save energy and simultaneously produce fewer emissions, the authors could come up with some comprehensive solutions;

The solar chimney in today's modern era can be regarded to as a creatively integrated concept which is currently under explorations, research and experimentation by some scientists as well as architects, to make it compatible with today's constructing methods. Besides an alternative use of wind catchers in connection to water reservoirs can help lessening energy consumption rate.

Before any further explanation regarding the demand for the traditional inventions in our life today, an environmental view should be taken into consideration. As it's generally accepted, a daily life full of relief and comfort while fewer emissions are produced is the most ideal for all human beings. In other words a good intention in reducing energy consumption while our normal life-habits not been affected is highly respected. In abidance to environmental issues, architects may focus on the operative temperature indoors and the applicatory methods to be adopted by people to save energy. It means for any innovation in our current architectural and urban planning strategies to save energy, the thermal comfort for residents is recommended to be speculated. By the way this paper has solutions for the following subordinates;

Improved passive cooling during warm seasons

Enhanced performance of thermal mass so that the emit of greenhouse gases is imminent

And finally improved thermal comfort as the heart of this research

1.1 Thermal comfort in the building

While we might not that much care for climatic situations outdoors, the liability of internal temperature is a must for almost all people. After a day of busy endeavours, the time when all family members get together can be considered as a golden time in a day to have all sorts of convenience nearby. From among all types of convenience thermal comfort is the most prevalent. That is the state of mind to express satisfaction with surrounding environment.

The ideal standard by thermal comfort can be defined by the operative temperature. This standard confirms that “amount of insulation required to keep a resting person warm in a windless room at 70 °F (21.1 °C)” ("Thermal Comfort", P. O. Fanger, McGraw-Hill, New York, 1970).

The authors claim that a smart use of vernacular architectural methods will help to reach that cosy temperature naturally and to maintain thermal equilibrium with the surroundings. Correspondent to a concord and vivid statement, one of the main trains in Architecture can be ingeminated into *providing comfort for residents*. And a primary factor in providing comfort in a heterogeneous architecture can be obtained through a vast use of organic and domestic architectural styles. “Organic architecture seeks superior sense of use and a finer sense of comfort, expressed in organic simplicity” (Frank Lloyd Wright).

The thermal comfort will be at hand if the natural ventilation systems can dissipate the heat generated by human metabolism. It’s however crystal clear that any heat gain or loss beyond this, generates a sensation of discomfort or a thermal stress.

1.2 Ventilation and Architecture:

Natural ventilation as a cost-effective and environmental-friendly method is the process of supplying and removing air through an indoor space by natural systems. Undeviating natural ventilation depends on how we can make the best use of architectural methods as are undertaken to make gratified ventilation. Before the methodology to be discussed later there are two traditional elements that are frequently used in Middle East and some African countries. Wind catchers and solar chimneys as two ventilating elements and Qanat an old conductive underground water flow for cooling, are attended to be introduced.

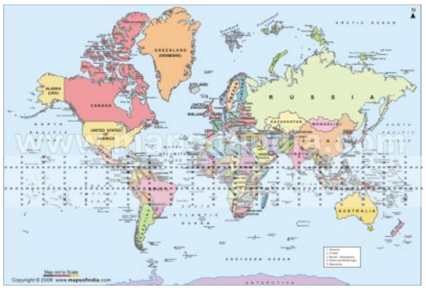
1.3 Aero dynamics

Firstly Wind tower is introduced as a main element found both in wind catchers and solar chimneys. Actually they can maintain natural ventilation in buildings. During the day the warm ambient air which is directed toward it can partially be cooled by the tower structure before entering the building.

Conventional and the modern versions of wind towers can be incorporated aesthetically into the designs of modern buildings in the hot-arid regions of the Middle East, and other areas of the world with similar climate, to provide summer thermal comfort with little or no use of electricity.

This system can be used for any country located in an enclosed area between tropic of Cancer and Capricorn. In accordance to map 1, a large section of the world lies within the tropics. As the majority of developing countries lie in tropical zone, a cost-effective and operational cooling system will be of the most value for them.

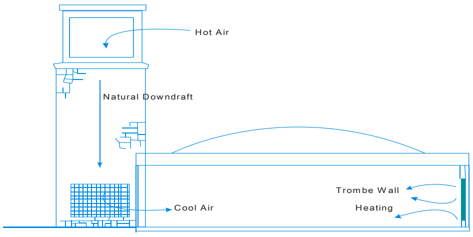
Map 1 Variety of the area where this method can be utilized



1.3.1 Wind catcher

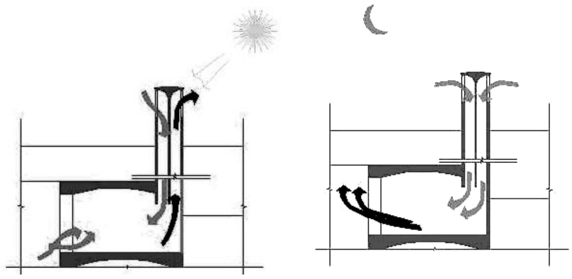
A wind catcher consists of a wind tower capped on top with several directional ports underneath. By opening the one facing the wind the air is pushed down the shaft while closing all but the one facing away from the incoming wind, air is drawn upwards. This generates significant cooling ventilation but is not enough to bring the temperature below ambient alone - it would simply draw in hot air through any windows or cracks in the structure as is shown in Fig.1 below.

Figure 1 Wind tower



At daytime, the sun hits on the southern face of the wind catcher and the temperature eventually goes up in that part. This air taken above through the inner air of the porch is compensated so a kind of proportional vacuum is made inside the porch. As a result it sucks in the cool air of the inner court into itself. Through this process the existing air in the northern opening will be pulled down as well.

Figure 2: Wind-catcher function during the day and night.



At night the condition diversely changes. The outside temperature falls down measurably and the cold air moves down. To discontinue with the blow of cold air, this air is saved by the heat that was collected inside the vernacular materials (adobe or baked clay) of the tower and becomes warm on parapets and then goes up. This circle can continue until the temperature of the walls and outside temperature will equal.

There are two kinds of traditional wind catchers. One is used for places were seasonal or inure winds have only one direction while the other type is used to trap multi-directional winds.

Figure 3 the annual wind-direction- Yazd-Iran

Multi-directional types of wind tower

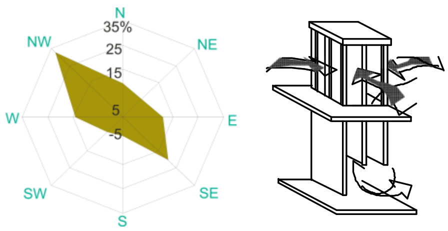


Figure 4 the annual wind-direction- Pakistan

Mono-directional types of wind tower

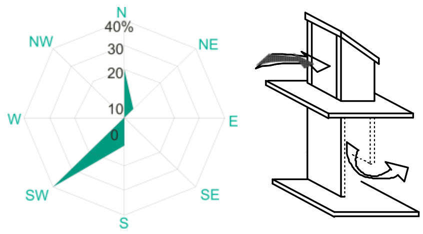
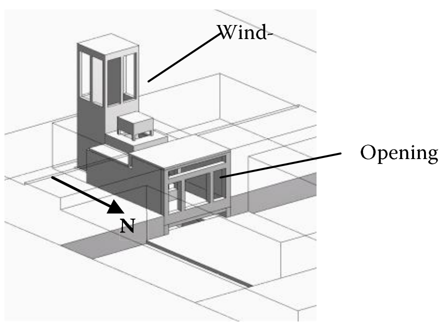


Figure 5 Analytic model

Multi directional types of wind tower



Single directional types of wind tower

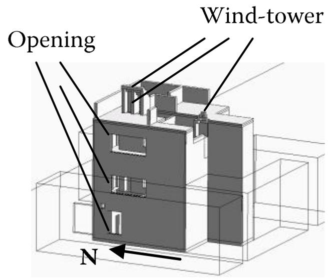
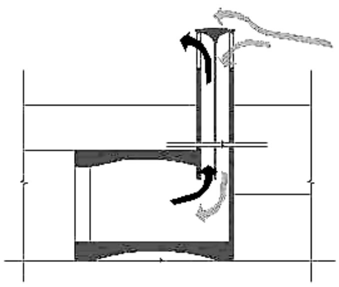


Chart 1 Wind catchers' comparison

Typical case	Model name	Multi-directional model Yazd-Iran				Mono-directional model Pakistan		
	Wind direction	North west	North west	South east	South east	West	West	West
	Harvesting/adopting wind tower	Closed	Opened	Closed	Opened	Closed	Opened	Opened
	Opening of window and the like	Opened	Opened	Opened	Opened	Opened	Opened	Closed
Assessment	X [mm]	972,000		267,700		75,000		
	Y [mm]	76,500		229,500		23,650		
	Z [mm]	51,200		51,200		44,700		
Number of cycles		28,800 （⊿t=6 Second, 48 hour long）						
External condition	Weather	Fine weather						
	Wind condition	Height 1 5m：Wind velocity 7m/s				Height10m：Wind velocity 3m/s		
		Turbulent model: Standard k-ε model						
		The exponent which should: 1/7						

A wind catcher is enough for making convection but we still need to more cool down the air. This goal can be complemented by the use of Qanats (A traditional water reservoirs in hot and arid regions particularly in Iran). The use of Qanat is very much similar to circulation of water in an integrated proceeding machine that can lower the temperature to a very idealistic one.

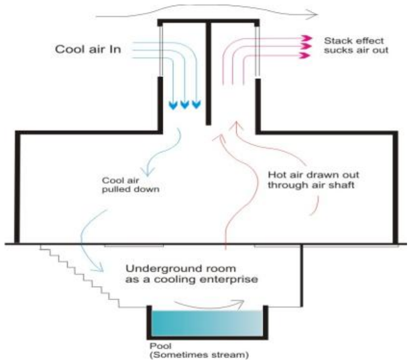
Figure 6: traction and suction in a wind-catcher



1.3.2 Qanat

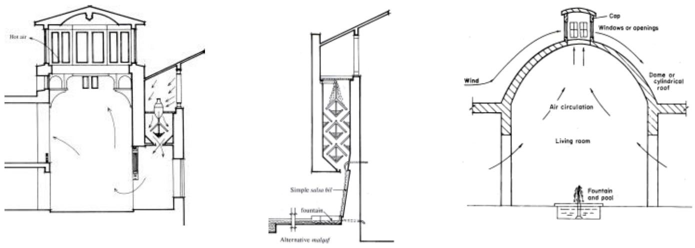
Qanats are constructed as a series of well-like vertical shafts, connected by softly sloping tunnels. By this technique taps into subterranean water in a manner that efficiently delivers large quantities of water to the surface without need for pumping can become executable. The water drains relying on gravity, with the destination lower than the source, which is typically an upland aquifer.

Figure 7 Qanat’s cross section



This can also allow water to be transported along distances in hot dry climates without losing a large proportion of the source water to seepage and evaporation.

Figure 8 Analogical circulation of water in traditional cooling systems



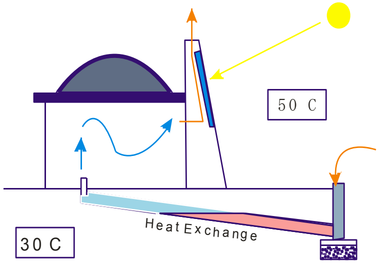
A Qanat has quite a lot of water inside, because there are frequent well-like reservoirs along its path. Completely shaded from the sun, a qanat also aggregates the cold, sinking air of the night, which is then trapped within, unable to rise up to the less dense surface air.

A windcatcher, however, can create a pressure gradient which sucks at least a small amount of air upwards through a house. This cool, dry night air, being pulled over a long passage of water, evaporates some of it and is cooled down further. To further maximize the cooling effect, the incoming air by the natural ventilation systems may be led through underground ducts before it is allowed to enter the building.

1.3.3 Solar chimney

A solar chimney can be utilized to pump outside air through an underground cooling tube during summer for building cooling. With use of no electricity, the solar chimney can be used to power the underground cooling system during daytime. During the day solar energy heats the chimney and the air within it, creating an updraft of air in the chimney. The suction created at the chimney's base can be used to ventilate and cool the building. Natural ventilation can be created by providing vents in the upper level of a building to allow warm air to rise by convection and escape to the outside. At the same time cooler air can be drawn in through vents at the lower level.

Figure 9 Solar chimney



2 Methodology

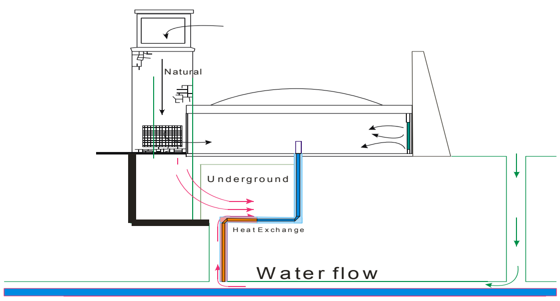
The authors suggest the use of multi-directional tower for the variety of uses it can make. There is also an opportunity to use it in different localities.

The Wind-Catcher and Solar Chimney are two of the ancient architectural elements that are suggested for the plan. The flow of water underneath is accessed as a natural air cooling enterprise. The use of underground pools or connection of a pipe to the nearest water flow can effectively cool down the gust of air. For each block of buildings a well that is connected to the underground water flow is required. Then by some pipes a network connection of them all together will be feasible. As it can be imagined, the Wind-Catcher and the Solar Chimney can be operated by the same pipe.

2.1 Procedure

An elaborative use of solar chimney, wind catcher and Qanat seems to be accommodating for Eco-buildings (Fig.10). Yet such eco-friendly structural aspects are here modified for only ventilations systems. As is shown in Fig.10 for each building there will be made a solar chimney tower facing the sun while a wind tower is located on the opposite side. The solar chimney's access to the underground water flow will be attained from alfresco while the wind tower will have the link directly from inside. The advantage of this method is the traction by solar chimney and evacuation from the wind catcher side. This all suffices for a productive convection which can be more impressive by chilling through the passage over water.

Figure 10 Solar chimney- Wind catcher and Qanat combination



For directing the air for cooling or heating some gables in the walls are needed to allow the air to blow in. The place we set them has an important effect in the cooling-heating results. For designing functional gables in the walls we the following factors ought to be considered. The diversified location of the gables will stipulate the following results;

In or near ceiling will cause horizontal discharge while in or near the wall will cause vertical non-spreading discharge. However a location of the gables in or near floor will cause vertical spreading discharge. The one which will later be implored a gable near the floor to duplicate the effectiveness the needed convection.

A victorious convection will result in decreasing the temperature to near the standard rate of 70 °F (21.1 °C)" ("Thermal Comfort", P. O. Fanger, McGraw-Hill, New York, 1970) as was previously discussed. A survey that was executed in a deserted city of Iran verifies the fact that the use of elaborative triple system will have some good results as is shown in chart2.

	Amended temperature	Temperature differential
Wind catcher & Solar chimney	30°C	40%
Qanat	10°C	80%
Triple system	22°C	56%

Chart 2 Temperature improvements (25m^2 rooms, outside temperature 50°C)

It's also standardized that a cooling system is required when the average outdoor temperature is above 18°C. By turning the air condition 1°C down the cooling bill can be saved up to 1%. According to U.S department of energy (http://www.energysavers.gov/) about 44% of the energy for power consuming systems is used for heating and cooling applications.

3 Discussion:

From an architectural point of view aesthetic issues are a lot important that functional considerations alone can not satisfy a scholarly work. On the other hand ecological trends here have no disagreement with beauty and steadiness of the structure. The vulgar or traditional methods are inwardly sensuous that their new or progressive usage for modern constructions is quite viable.

3.1 Architectural view-point

An integrated use of the solar chimney and the wind-catcher may benefit natural ventilation and passive cooling strategies of buildings thus can help reduction of energy use, CO2 emissions and pollution in general. Besides conductivity of the used materials detached and the mass as a whole convey crucial effectiveness.

Chart 3 Analytical mesh values

Physical properties values	Multi-directional model		Mono-directional model	
	Adobe tile (Structure)	Soil (Land)	Gypsum (Structure)	Lumber (Floor .window)
Density [kg/m³]	1.406×10^{3}	1.890×10^{3}	2.623×10^{3}	5.200×10^{3}
Heat capacity [J/kgK]	8.000×10^{2}	8.400×10^{2}	3.238×10^{2}	9.072×10^{2}
Coefficient of thermal conductivity [W/mK]	3.000×10^{-1}	6.300×10^{-1}	2.130×10^{-1}	1.790×10^{-1}

Due to considerable conductivity in domestic materials, adjoined rooms confronted to the one with wind tower, need no opening in the walls. Naturally the temperature in adjoined spaces would be slightly higher than those located in the core of the ventilation. In case of inconvenience the system can improve by instalment of internal gables (already discussed in part 2.1 of the current paper for suggesting a gable near the floor to duplicate the potential convection rate). In wide spaces lack of extra gables will cause rooms temperature for the thermal movement as advanced as outside air temperature. Expansion or contraction of a substance will also result in thermal movement as a response to changes in temperature that frequently occur in arid areas.

On the other hand the flow of air over water will purify the air and split out the dust and blur. Sprinkle of water and splashing it all over will also broaden the possibility to reach thermal comfort. Just keeping in mind that majority of places in tropical zone suffer from lack of cleanliness of the air. So, humidified ventilation can be produced while traditional methods are implied.

Achievement in chilling spaces successfully, the natural ventilators already discussed can provide a constant, draught-free flow of fresh air, while the warm used air rises and is extracted from wind catcher terminals on the roof.

4 Conclusion

The natural air-conditioning emits greenhouse gases and contributes to global warming, consume up to over 50 per cent electricity in buildings in most developing countries. Most of those countries are located in hot regions so during summer, there is a tremendous consumption of energy, which can be drastically reduced through natural ventilation. This can be obtained by an integrated use of traditional cooling systems. Hot air from outside combined with the cool misty air and the cooled air is passed through the entire building. To double the effectiveness, we can direct the wind in a way to blow over a water surface. This will turn down the rate of energy consumption in buildings considerably. The reduction of energy consumption by this method reaches up to the rate of about 50%. This can significantly lower the carbon quotient of the building. While over 90% of the energy saved by natural ventilation systems relate to electricity consumption, yet 10% of which is used by the construction materials. In order to have more reliable outcome, insulation is a key to succeed through preventing external heat from entering or the internal cool air to exit. Also, natural ventilation can be used at nights in summer to lower inside temperatures. If windows are kept open at night, the trapped hot air can be ventilated and keep the room cool".

Modern architecture in many features is awesome however in relations with our nature might be somehow disadvantageous. According to an investigative report from the American World Observation Institute, "about 40 percent of raw material and energy of the world is used by buildings, and besides fuel about 55 percent timber is also used by buildings, whereas these buildings not only consume energy, but also do harm to human health". However significant reduction in carbon dioxide emissions by natural ventilation systems can reduce energy consumption by up to 50%, compared with air-conditioned buildings, and can offer 75% savings on maintenance costs as well.

4.1 Ecological & Economical issues:

There is another good point with the Natural Ventilation as it offers a quick return on investments. There is also no risk as found in stock market or other interesting topics for investors. On the other hand it can also guaranty a better business economy. Effective exploitation of the forces of nature generates large savings in energy consumption and maintenance. Natural Ventilation with advanced control is considerably simpler and therefore involves less investment in equipment than traditional mechanical ventilation systems. Natural Ventilation eliminates the need for mechanical ventilation and cooling, which is very energy-intensive, and at the same time saves the maintenance of technically complex systems. Natural ventilation is beneficial for the following reasons;

- It is healthy ventilation, for it can promise a good indoor air quality.
- It is thermal comfort ventilation. Natural ventilation can increase the heat given out by human, and prevent uncomfortable feeling due to watery skin, and improve thermal comfort condition;
- It is temperature decreasing ventilation. It can decrease the temperature of building components when the indoor temperature higher than that of outdoor.

As there is no fossil source of energy at use, within the first step this energy replacement will be a good help for our environment. In the world today where the demand for fossil sources is overwhelming a substitute source of energy will be highly awarded. For economists and governmental decision makers no subject is as eye-catching as the one related to an efficient use of electricity.

While there are a lot of volunteer communities or nature lover non-profit organizations all active to find solutions to assist the earth respiration, architects and urban planners can play their part to commence a worldwide campaign for all those who have a beating heart for environment.

Geographical specifications are also important to identify what temperature is most expected to satisfy people. Whatever it is the temperature inside needs to be stabilized with a constant blow of pleasant air. This can in fact provide a stable pleasant temperature inside.

5 References

5.1 Chapter of a book

Fanger, P. O., McGraw-Hill, (1970),"Thermal Comfort", New York

5.2 Book

Designer's Guide to Ceiling-Based Room Air Diffusion, Rock and Zhu, ASHRAE, Inc., Atlanta, GA, USA, (2002)

ANSI/ASHRAE Standard 62.1, ‘Ventilation for Acceptable Indoor Air Quality’, ASHRAE, Inc., Atlanta, GA, USA

ASHRAE, Elsevier, Burlington, MA, ‘Ventilation for Environmental Tobacco Smoke’, USA, (2006)

5.3 Thesis

Bahadori, Mehdi N. (August 1994). "Viability of wind towers in achieving summer comfort in the hot arid regions of the middle east". *Renewable Energy* 5 (5-8): 879–892.

5.4 Conference paper

Abbas Ali Elmualim, BSc Arch, Hons MSc Arch MSc PhD. Innovative Construction Research Centre, School of Construction Management & Engineering, TheUniversity of Reading, UK)

Bansal, N. K.; Rajesh Mathur & M. S. Bhandari (July 1993). *Building and Environment* (Elsevier Science Ltd.) 28 (3): 373–377.

Ezzati, M., and D. M. Kammen. 2002. "The health impacts of exposure to indoor air pollution from solid fuels in developing countries: knowledge, gaps, and data needs." Environmental Health Perspectives 110.11 (Nov 2002): 1057(12). 27 April 2007.

Keiko Sugawara，Kiyotaka Deguchi，Hidenobu Jinnai，Naomi Ando, "Numerical Simulation Analysis of Thermal Environment of Vernacular Architecture-About the House with Wind Catchers"

Nader Ardalan and Laleh Bakhtiar. Sense of Unity; The Sufi Tradition in Persian Architecture. 2000.

Pearlmutter, D.; E. Erell, Y. Etzion, I. A. Meir, H. Di (March 1996). "Refining the use of evaporation in an experimental down-draft cool tower". *Energy and Buildings* (Elsevier) 23 (3): 191–197.

Incorporating an economic measure into Ecohomes

Doug Forbes[1], Dr Mohamed El-Haram[2], Prof. Malcolm Horner[2], Dr Simon Smith[3]

1 – Whole Life Consultants Ltd, UK

2 – University of Dundee, UK

3 – University of Edinburgh, UK

BREEAM is the Building Research Establishment's Environmental Assessment Method. It is a suite of tools designed to measure the environmental performance of buildings. Although originally designed for a UK context it has been adapted for and influenced a range of building rating systems world-wide. The domestic scheme, Ecohomes, has received widespread acceptance for the assessment of housing, particularly in the social housing sector. Ecohomes was originally designed as an environmental assessment method. However, recent revisions have seen an increased inclusion of social issues. The problem, however, exists that no attempt is made to include the economic dimension of sustainability. It is therefore the purpose of this paper to investigate the coverage of the assessment method over the three dimensions of sustainability and respond accordingly to any gaps.

The analysis for the coverage of the indicators found, unsurprisingly, that there is a very reasonable coverage of environmental indicators in Ecohomes. This was complemented by a reasonable coverage of social indicators. However, there is a complete avoidance of the economic dimension.

It was proposed that means of incorporating an economic dimension should be considered to make it a three dimensional sustainability assessment method. The approach developed in this paper uses published distributions of capital construction costs of houses and flats from the Building Cost Information Service (BCIS). Using these distributions a sustainability ratio is developed based on the existing Ecohomes score to measure the environmental and social dimensions while the capital construction cost defines the economic dimension. A set of grades can then be creates to measure a three dimensional Ecohomes score. Thus, the research presented allows an opportunity to see the impact and the effect of all three dimensions of sustainability simultaneously. It is possible that with further industrial consultation the approach could be transferred and applied to other building rating methods, for instance LEED. There are also, however, limitations associated with the approach which stem from a lack of reliable data.

Keywords: BREEAM, life-cycle costing, sustainable built environment, sustainability assessment

1 Introduction

Sustainability takes into account social, economic and environment issues. The built environment has a significant impact on all three of these, although the exact impact is a matter of current debate. For example, environmentally in the UK buildings account for around half of carbon emissions and one third of landfill waste (HM Government 2008). Socially, poor physical conditions have been detrimental to communities (Egan 2004). It is therefore not surprising that buildings have become a focus for government in striving to meet sustainability targets. This is seen clearly in the UK as the government is using the housing sector as a principal means of policy delivery- particularly in relation to carbon emissions. The target in England and Wales is for net zero carbon homes by 2016 (CLG 2007). One of the tools used to measure delivery of this is the Code for Sustainable Homes (CLG 2008). The Code is to a large extent based on the BREEAM (Building Research Establishment's Environmental Assessment Method) for homes - Ecohomes. Ecohomes was first developed in 2000 and supplemented a suite of assessment methods which previously existed for non-domestic buildings (Rao *et al.* 2000). BREEAM was the first simplified environmental certification scheme of its kind when it was developed in 1990 (Howard 2005). Its development since has, itself, influenced the development of other assessment methods throughout the world (Cole 2006). Ecohomes underwent revisions in 2003, 2005 and 2006. It was the main environmental assessment method for housing in the UK until the Code was introduced. Since May 2008, there has been a mandatory requirement for all new homes in England to be assessed under the Code (CLG 2008). In Scotland, the standard remains Ecohomes 2006.

2 BREEAM & Ecohomes

The suite of BREEAM non-domestic schemes and Ecohomes all function in similar ways. There are eight headline categories which are measured: i) Energy; ii) Transport; iii) Pollution; iv) Materials; v) Water; vi) Land Use & Ecology; vii) Health and Wellbeing and viii) Management. Under each of the issues a set of points is awarded. These are then calculated as a percentage of the total available for each issue. The score achieved from the credits for each issue is then multiplied by the weight. This provides a weighted score, which is the overall assessment score. This score is then translated into a building rating: 'Pass' (>36%); 'Good' (>48%); 'Very Good' (>58%); 'Excellent' (>70%).

The points awarded in each category are based on indicators. The indicators are specific to the type of building being assessed. For instance, the indicators for transport differ between domestic and non-domestic buildings. In Ecohomes the indicators are tailored to the housing sector. For instance, the water category is measured in part by the annual potable water use; energy in part by the dwelling carbon dioxide emission rate.

An important issue associated with Ecohomes has been its incremental and evolutionary development. Originating as an environmental assessment method it is evidently very strong at measuring the environmental dimension of sustainability. However, it is clear that there are a number of indicators designed to measure and award points for social considerations. It also appears that there is an almost complete dearth of indicators to attempt to measure the economic dimension despite these observations. The question which remains is how comprehensively does Ecohomes address each of the three dimensions, if at all?

3 To what extent does Ecohomes address all three dimensions of sustainability?

The response to the question of whether Ecohomes addresses all three dimensions of sustainability opens up a larger problem: what should be measured in a sustainability assessment? Research undertaken by the SUE-MoT project has investigated Metrics, Models and Toolkits for Whole Life Urban Sustainability (SUE-MoT 2007). One of the work packages in this research has developed a full cost accounting package for sustainability of urban developments. This is called the Urban Developments Sustainability Assessment Model (UD-SAM) (Xing *et al.* 2007). The researchers identified a set of key impacts for sustainability of urban developments. These impacts were compiled from an extensive review of the literature which identified in excess of 600 sets of sustainable development indicators. These were then considered and validated by stakeholders through a workshop and a questionnaire survey. This defined 24 significant impacts of sustainability (Xing *et al.* 2007). Further work has developed and simplified these into 18 impacts (El-Haram *et al.* 2008). These impacts are grouped under the three headline dimensions of social, economic and environmental issues.

3.1 An approach to consider the coverage of indicators

The indicators in Ecohomes were cross-mapped with the UD-SAM impacts which they address. This investigated how comprehensively Ecohomes measured the 18 impacts used in the UD-SAM, and consequently, therefore addressed all three dimensions of sustainability. This mapping exercise is presented in Figure 1.

The ability for Ecohomes indicators to measure the social, environmental and economic issues was defined on two levels. The first of these considered whether the primary aim of the indicator was to address the impact. The second level considered whether the impact was addressed as a by-product of the metric used in the indicator. This mapping exercise identified that all of the environmental and most of the social impacts were measured by at least one of the 33 indicators in Ecohomes. The only social impact not measured was the impact on heritage. There was no indicator representing any impacts in the economic dimension.

A subjective assessment was then made of the extent to which each of the impacts is measured using Ecohomes. This considered each of the UD-SAM impacts in turn and the ability of Ecohomes to measure each dimensions of sustainability. Three degrees of coverage were defined for Ecohomes. These were 'low', 'medium' and 'high'. The associated definitions are outlined in Table 2. The associated level for each of the 18 UD-SAM impacts is presented in Table 2.

UD-SAM SIGNIGFICNAT IMPACTS		Energy						Transport				Pollution					Materials				Water Use		Land Use & Ecology					Health & Wellbeing			Management			
		Ene 1 Dwelling Emission Rate	Ene 2 Building Fabric	Ene 3 Drying Space	Ene 4 EcoLabelled Goods	Ene 5 Internal Lighting	Ene 6 External Lighting	Tra 1 Public Transport	Tra 2 Cycle Storage	Tra 3 Local Amenities	Tra 4 Home Office	Pol 1 Insulant GWP	Pol 2 NOx Emissions	Pol 3 Reduction of Surface Runoff	Pol 4 Renewable and Low Emission Energy Source	Pol 5 Flood Risk	Mat 1 Environmental Impact of Materials	Mat 2 Responsible Sourcing of Materials: Basic Building Elements	Mat 3 Responsible Sourcing of Materials: Finishing Elements	Mat 4 Recycling Facilities	Wat 1 Internal Potable Water Use	Wat 2 External Potable Water Use	Eco 1 Ecological Value of Site	Eco 2 Ecological Enhancement	Eco 3 Protection of Ecological Features	Eco 4 Change of Ecological Value of Site	Eco 5 Building Footprint	Hea 1 Daylighting	Hea 2 Sound Insulation	Hea 3 Private Space	Man 1 Home User Guide	Man 2 Considerate Constructors	Man 3 Construction Site Impacts	Man 4 Security
Environmental Impacts	Material Use														P		P	S	S	S											S		S	
	Energy	P	P	P	P	P	P										S	S	S												S			
	Water (including impacts on hydrological assets)													S		S	S				P	P									S			
	Land Use																						S	S	S	S	P					S	S	
	Pollution to air (Local Air Quality)							S	S	S	S		P		S		S														S	S	S	
	Global Air Quality (Climate Change)	P	P	P	P	P	P	P	P	P	P	P			P		S	S	S												S	S	S	
	Pollution to Land (Land contamination)													S		S																S	S	
	Pollution to Water (Water contamination)													P		P																		
	Ecological health (eg. Change in biodiversity)																S	P	P				P	P	P	P	S					S	S	
	Waste																S			P											S	S	S	
Social Impacts	Crime						S		S																									P
	Safety						S	S		S																					S	S		
	Health												S															P	P	P				
	Social Capital							S		S	S																		S	S	S	S		
	Mobility							S	S	S																					S			
	Heritage																																	
Economic Impacts	Multiplier Effect of Jobs																																	
	Whole Life Value																																	

P	Primary aim of indictor addresses the impact
S	Secondary aim of indicator addresses the impact

Figure 1 Comparison of Ecohomes indicators with urban sustainability impacts

Table 1 Definitions used to define the range of indicator coverage

Coverage	Definition
Low	Not covered at all by Ecohomes
Medium	Covered in part by Ecohomes
High	Comprehensively covered by Ecohomes

Table 2 Range of coverage of urban sustainability issues in Ecohomes

Dimension of Sustainability	Impact	Probability of failure to be addressed Ecohomes	
Environmental	Material use	High	
	Energy	High	
	Water (including impacts on hydrological assets)	High	
	Land use	High	
	Pollution to air (local air Quality)	High	
	Global air quality (climate change)	High	
	Pollution to land (land contamination)	High	Medium
	Pollution to water (water contamination)	High	
	Ecological health (eg. change in biodiversity)	High	
	Waste	High	
Social	Crime	High	Medium
	Safety	Medium	
	Health	High	
	Social capital	Medium	
	Mobility	Medium	
	Heritage	Low	
Economic	Multiplier effect of jobs	Low	
	Whole life value	Low	

3.2 The coverage of indicators in Ecohomes

This analysis demonstrates that Ecohomes has a reasonably comprehensive set of indicators to measure the environmental impacts of sustainability. This is unsurprising, and given the historic background to Ecohomes. The only impact of concern in the ability of Ecohomes to measure environmental issues was pollution to land. However, this was compensated by the reasonable coverage of this impact by secondary aims of indicators, and the comprehensive coverage of other environmental impacts. In contrast to relatively full coverage of environmental impacts there is a complete failing of Ecohomes to take account of economic impacts. It is noted that a whole life cost exercise is included in the renewable energy feasibility study for awarding Pollution 4 credits (Renewable and Low Energy Emission Energy Source). However it is not the primary or secondary aim of this indicator. The scope is limited to renewable energy sources at feasibility stage and has therefore not been considered as a by-product of the indicator. This does not therefore address the economic impacts in the UD-SAM.

The economic and environmental impacts are the two extremes while the social issues lie in-between being partially covered. All of the social issues were covered, at least in part, by Ecohomes indicators, except heritage. The health impacts were considered to be comprehensively covered. This is due to the inclusion of the health and wellbeing category in Ecohomes. The primary aims of all three indicators in this category address this aim. The crime impact was considered to be addressed between ‘comprehensive’ and ‘in part’ levels. This was due to a mixture of primary and secondary indicators which do not address these issues in sufficient detail to merit a 'high' rating of coverage.

Ecohomes indicators covered the safety, social capital and mobility issues in part. However, the very nature of these three impacts creates difficulties in their measurement (Pearce 2006, Moobela *et al.* 2007). They have been addressed in Ecohomes through a range of secondary indicators. Therefore, it cannot be considered that a comprehensive approach has been developed.

3.3 Does Ecohomes address all three dimensions?

Findings from this analysis are important because it effectively demonstrates the extent to which Ecohomes addresses sustainability issues in three dimensions. While it is widely considered that Ecohomes is an environmental assessment method, recent revisions have included an increase in social indicators. Introducing these indicators has resulted in an approach which considers, to a large extent, all the social impacts associated with sustainability. However, most of the social impacts are addressed by secondary aims of the indicators. Thus, it would seem that apart from crime and health this inclusion has been an ‘add-on’ rather than a deliberate attempt to incorporate the social dimension. However, the social dimension is amongst the least understood in sustainability. Therefore it is considered that there is a reasonable coverage of these two issues in Ecohomes.

However its ability to measure both the environmental and social dimensions of sustainability simultaneously means that the assumption that Ecohomes is purely an environmental assessment needs to be dismissed. Ecohomes must be applied in the context and with the understanding that a large number of social impacts are also considered, albeit via the secondary aim of certain indicators. It is vital, however, that if Ecohomes is to measure sustainability fully then metrics for the economic issues must be included.

4 The coverage of Ecohomes indicators

The issue remains that while Ecohomes measures environmental and social dimensions to a reasonable extent, it fails entirely to take account of the economic dimension in a meaningful manner. This is unacceptable if Ecohomes is to truly measure sustainability in three dimensions. The remainder of this section discusses an approach proposed to incorporate economic considerations.

4.1 The cost of sustainable housing

The additional cost of 'sustainable' construction is, like many issues in sustainability, a debatable issue. In the housing field two comprehensive studies have been published which investigate the cost of achieving different levels in the Code and Ecohomes. However, because of the multitude of combinations which are possible, and the constraints placed on the assessment by site and design conditions, it is difficult to define consistent base-cases. The Ecohomes study was performed by BRE and Cyril Sweet. It was based on Ecohomes 2003 and considered a building regulation compliant house. The three base-cases in the study considered a poor, typical and good site, with respective scores of 22.1%, 27.6% and 29.7%. It was estimated that price increases of 0.1% to 6.9% were necessary to achieve an ‘Excellent’ rating (BRE and Cyril Sweett 2005a, b). Townshend (2007) found that a developer in Newcastle, England incurred additional costs of 7.5% to achieve Ecohomes excellent. An updated study considering the Code for Sustainable Homes (Housing Corporation and English Partnerships 2007) estimated that to achieve Level 6 additional construction costs in the region of 25-37% are required. This large increase in construction costs is reflected by The Stewart Milne Group who are one of the first house-builder to build to Level 6 of the Code. They estimate, at prototype stage of a 3/4-bedroom detached property, Level 5 will add £40,000 to construction costs. Level 6 will increase the construction costs in the region of £60,000-£70,000 (Peedle 2007).

Despite the increased capital cost a small number of studies investigate the effect of increased sustainability on whole life costs. Zhou and Lowe (2003) concluded that considering costs on a life cycle is the key to incorporating the economic dimension of sustainability. Smith et al. (1997) noted that despite a 1.1% increase in capital costs, savings of 10.3% (using a 3.88% discount rate) and 5.2% (using an 8.00% discount rate) over a 60 year life cycle were achievable in more sustainable housing. Similar savings over the life cycle were found by the Environment Agency (Horton 2005). Their research demonstrated that over a 25-year life cycle savings of £11,834-16,679 per dwelling were possible using a 3.5% discount rate from an increased spend of £7,100-£22,100.

4.2 Incorporating the economic dimension

The impacts which were included in the UD-SAM proposed the multiplier effect of jobs and whole life value as the economic impacts. The inclusion of an indicator which can attempt to measure these in Ecohomes is now considered. This will increase the ability of Ecohomes to comprehensively measure sustainability in three dimensions.

The research presented above highlights the discord which exists in the published cost of sustainable housing and the effect on whole life costs. In principle, the incorporation of the economic dimension of sustainability in Ecohomes would take account of whole life costs. However, an approach has been developed in this research which uses the capital construction cost of the dwellings. Capital costs were used because insufficient reliable data could be obtained for whole life costs. Quarterly costs for construction of housing are published for the UK by the Building Cost Information Service (BCIS). Table 3 gives the distribution of costs for flats and houses (BCIS 2008). The prices given are for a UK mean location, and are based on prices in the fourth quarter of 2007. They are given per square metre of gross internal floor area, excluding external works and contingencies. Preliminaries should be distributed in proportion to cost.

Table 3 Cost per unit area for housing and flats (BCIS 2008)

Percentile (%)	Housing (£/m2)	Flats (£/m2)
10	216	314
20	272	432
30	325	536
40	372	633
50	412	706
60	460	820
70	533	906
80	593	1065
90	727	1286
100	1897	2657

The approach developed ensures that costs are minimised while maximising the social and environmental benefits. The social and environmental benefits are measured by the Ecohomes score. The research carried out in the earlier part of this paper demonstrated the effectiveness of the existing Ecohomes method to measure this. The costs are measured using the construction cost per square metre indexed for temporal and location differences detailed above. A distinction between flats and houses has been used. This is a distinction which is inherent in Ecohomes. Five grades of award have been defined in this research; these reflect the five grades in the current Ecohomes version. These have been entitled Grade A – D and fail. The relationship between cost and Ecohomes score is given in Figure 2 and Figure 3 for houses and flats respectively

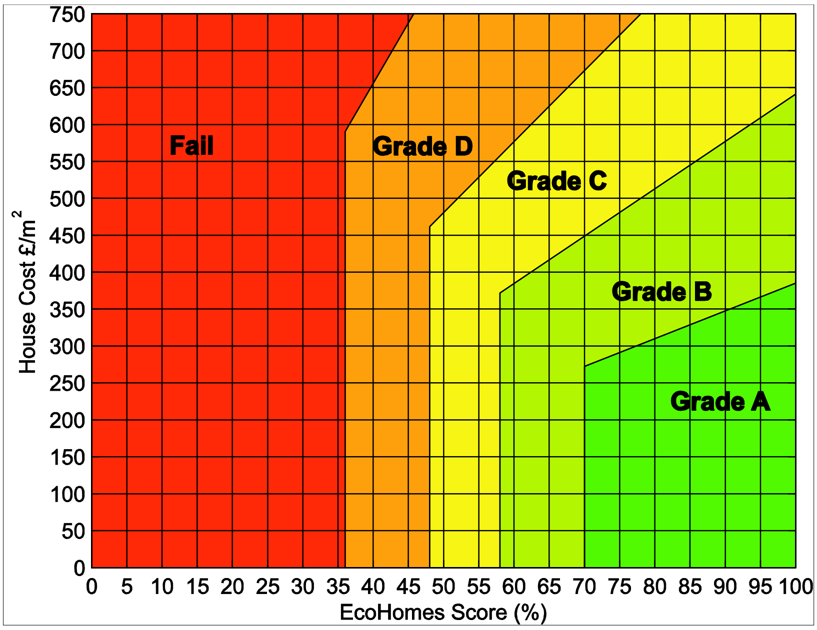


Figure 2 Thresholds to incorporate economic dimension with Ecohomes score for housing

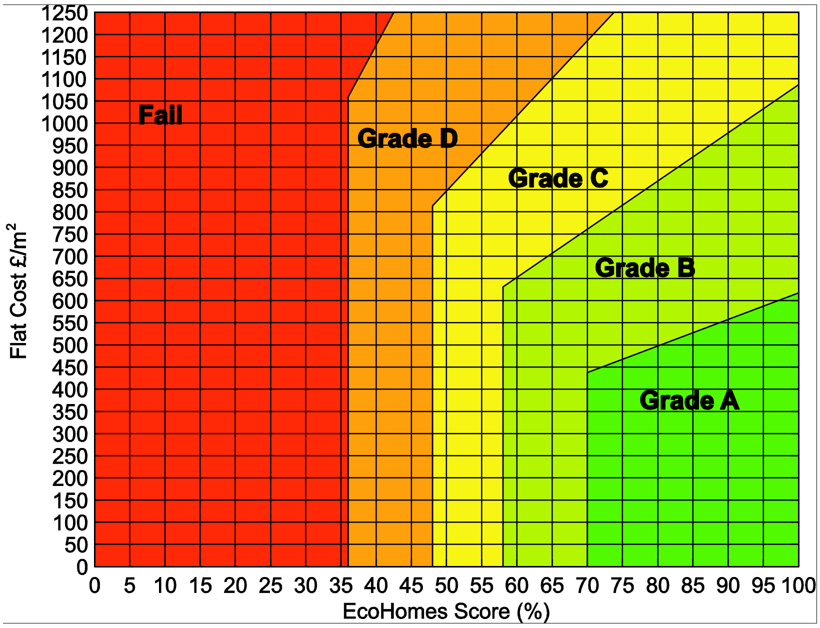


Figure 3 Thresholds to incorporate economic dimension with Ecohomes score for flats

The boundaries have been defined by incorporating two measures. The thresholds on the horizontal axis are defined by the existing Ecohomes score thresholds. The Ecohomes score thresholds are defined by BRE to award developments which are going beyond the regulatory minimum. An 'Excellent' rated development is therefore at the higher percentiles of environmental and social performance. Using this basis the costs were split into five equal segments, to mirror the five Ecohomes ratings. The boundaries for this were taken as the 20, 40, 60 and 80 percentiles. These were selected to mimic the five existing bands of Ecohomes ('Fail'; 'Pass'; 'Good'; 'Very Good'; 'Excellent'). In theory these bands should be sized to reflect the distribution of the number of properties in each Ecohomes rating. For instance, if 10% of new homes are 'Excellent' then this would be within the top 10% of cost. However as the distribution of number of dwellings in each rating is unavailable a uniform distribution was assumed. The points of inflection were established by the point where the 20 percentile of costs coincided with the 'Excellent' threshold of 70%; the 40 percentile coincided with the 'Very Good' threshold of 58% and similarly for the remaining limits. Defining these points in this way ensures that buildings which achieve an 'Excellent' performance environmentally and socially are also delivering it within the top 20% of unit cost. However, to allow for an increased cost as the Ecohomes score exceeds the social and environmental thresholds, the grade boundaries are sloped. The slope of these lines is defined by the ratio of Ecohomes score to cost at the point of inflection. For instance for housing to be 'Grade A' it must be in the top 20 percentile of cost (< £272/m2) at an Ecohomes score of 70%. This ratio is 0.257. Therefore if the same project were to obtain a score of 90% it must maintain costs below £350/m2 (90÷0.257). This grading process encourages developments to aim for the bottom right hand corner of the chart: maximum social and environmental benefits for minimum cost. The sloped boundaries account for increased costs associated with higher levels of sustainability.

Whilst useful in defining the boundaries, a graphical display is not the most effective method for this approach to be for assessment process. Additionally it is not consistent with the format of the Ecohomes Guidance which uses numerical values as thresholds. A three dimensional Ecohomes score ratio of unit cost to Ecohomes score can be calculated from the ratio given in Equation 1.

$$Ratio = \frac{EcoHomes\ Score\ (\%)}{Cost\ per\ unit\ area\ (£/m^2)} \qquad (1)$$

This ratio should be maximised to achieve the greatest measure of sustainability in three dimensions thereby achieving the highest possible social and environmental benefits for the minimum unit cost. The thresholds have been defined for each of the grades in Table 4 using the points defined by the charts in Figure 2 and Figure 3. To obtain each grade a development must have an economic ratio higher than that given in columns [2] and [3] for houses and flats respectively and an Ecohomes rating higher than that given in column [4].

Table 4 Gradings defined for three dimensions sustainability measure using Ecohomes

Grade Rating [1]	**Economic Score Thresholds**		**Ecohomes Thresholds (Social & Environmental Score) [4]**
	Housing Ratio [2]	**Flats Ratio [3]**	
Grade A	>0.26	>0.16	≥70%
Grade B	>0.16	>0.09	≥58%
Grade C	>0.10	>0.06	≥48%
Grade D	>0.06	>0.03	≥36%
Fail	≤0.06	≤0.03	<36

4.2.1 The proposed approach to incorporate an economic dimension

This process has developed an approach by which the economic dimension can be considered in conjunction with the social and environmental issues measured by Ecohomes. It rewards assessments which maximise Ecohomes score whilst minimising cost per unit area. Regional and temporal differences in cost are taken into account by indexing the costs to a UK mean location and the fourth quarter 2007 prices. This creates an indicator to measure the economic dimension of sustainability. The comparison with the UD-SAM highlighted two economic issues in sustainability assessment of urban developments: whole life value and the economic multiplier effect of jobs. This indicator attempts to measure the first of these and creates a step forward in forming a three dimensional measure despite some notable limitations. It is acknowledged that this approach is limited by only including the capital cost. However, while this may seem contradictory to the measure of whole life value, it has been shown in a limited number of studies that increasing the environmental and social sustainability reduces the whole life costs. To an extent the environmental and social metrics measured by Ecohomes take account of the impact of the dwelling over the whole life. However, further investigation is required of the effect of increased Ecohomes score on whole life costs. Further research is required to determine if whole life costs or capital costs are more appropriate to use as a metric for economic impacts.

5 Conclusions

Ecohomes, and the remainder of the BREEAM suite, are amongst the most commonly used sustainability assessment methods for buildings. One of the challenges associated with their use is the extent to which they actually assess sustainability; indeed what is actually meant by sustainability in the first place. If it is assumed that sustainability incorporates three dimensions: environmental, social and economic then Ecohomes does not measure all three. It does however cover social and environmental issues. This means that it can be effectively used to measure social and environmental dimensions. This highlights an important aspect that despite its origins as an environmental assessment method it cannot be used in its current form to measure solely the environmental dimension. The social indicators included are too numerous to permit this.

The approach used to incorporate an economic dimension has embraced the assumption that Ecohomes as it currently stands serves as an effective measure of social and environmental dimensions. It has then used this measure and combined it with the current distribution for construction costs of domestic construction in the UK. This has developed a three dimensional sustainability ratio which can be used to grade the housing development.

The approach is limited by using the data from only one source, BCIS. The method uses the current distribution of costs for housing per unit area and does not take any account of increased costs incurred by increasing sustainability or whole life costs. Further consultation and research is required to define the threshold points for each grade. However, this approach is considered a significant step forward in the ability of Ecohomes to measure the three dimensions of sustainability. Additionally, it has potential for adaptation to other types of BREEAM assessed buildings and other building rating systems based on BREEAM. It should also be noted that there is no inclusion of the second significant economic impact, the multiplier effect of jobs. Further opportunities to include the multiplier effect of housing should be considered in future research.

6 References

BCIS (2008) BCIS (Building Cost Information Service) Online. [Available online from http://service.bcis.co.uk/], accessed 22 Feb 2008

BRE and Cyril Sweett (2005a) Costing sustainability: How much does it cost to achieve BREEAM and Ecohomes ratings? (IP 4/05). Watford: BRE Press.

BRE and Cyril Sweett (2005b) Putting a price on sustainability. Watford: BRE Press.

CLG (2007) Building a Greener Future: Policy Statement. [Available online from http://www.communities.gov.uk/documents/planningandbuilding/pdf/building-greener.pdf], accessed 28 September 2007

CLG (2008) The Code for Sustainable Homes: Setting the standard in sustainability for new homes. [Available online from http://www.communities.gov.uk/documents/planningandbuilding/pdf/codesustainhomesstandard.pdf], accessed 3 March 2008

Cole, R J (2006) Shared markets: Coexisting building environmental assessment methods. Building Research and Information, 34(4), 357-71.

Egan, J (2004) The Egan Review: Skills for Sustainable Communities. London: ODPM.

El-Haram, M, Horner, M, Xing, Y and Bebbington, J (2008) Data Framework for Urban Sustainability Accounting. In, Transformation through Construction: Joint Symposium of CIB Working Groups W055 and W065, 15-17 November, Dubai.

HM Government (2008) Strategy for Sustainable Construction. [Available online from http://www.berr.gov.uk/files/file46535.pdf], accessed 10 June 2008

Horton, B (2005) Sustainable Homes - the financial and environmental benefits. Science Report SC40050/SR. Bristol: Environment Agency.

Housing Corporation and English Partnerships (2007) A cost review of the Code for Sustainable Homes. [Available online from http://www.cyrilsweett.co.uk/pdfs/Code%20for%20sustainable%20homes%20cost%20analysis.pdf], accessed 8 May 2007

Howard, N (2005) Building Environmental Assessment Methods: In Practice. In, The 2005 World Sustainable Building Conference (SB05Tokyo), Tokyo, 2008-15.

Moobela, C, Price, A D F, Taylor, P J and Mathur, V N (2007) Determinants of Social Capital: Prioritising Issues for Holistic Urban Sustainability Assessment. In: Horner, M, Hardcastle, C, Price, A and Bebbington, J (Eds.), International Conference on Whole Life Urban Sustainability and its Assessment, 27-29 June, Glasgow.

Pearce, D (2006) Is the construction sector sustainable? Building Research and Information, 34(3), 201-7.

Peedle, R (2007) Low Carbon Economy - policy into practice: Presentation at BRE Annual Conference. [Available online from http://www.bre.co.uk/filelibrary/Scotland/Annual%20Conference%202007/BRE_Scotland_presentation_ppt_%5BRead-Only%5D.pdfStewart_Milne.pdf], accessed 1 February 2008

Rao, S, Yates, A, Brownhill, D and Howard, N (2000) Ecohomes : the environmental rating for homes. London: Construction Research Communications Limited.

Smith, M, Whitelegg, J and Williams, N (1997) Life cycle analysis of housing. Housing Studies, 12(2), 215-29.

SUE-MoT (2007) Metrics, Models and Toolkits for Whole Life Sustainable Urban Development: Research. [Available online from www.sue-mot.org/research], accessed 14 February 2008

Townshend, T (2007) Why Aren't We Building More Sustainable Residential Neighbourhoods In The UK? International Journal of Sustainable Development and Planning, 2(2), 222-38.

Xing, Y, Horner, M, El-Haram, M and Bebbington, J (2007) A framework model for assessing sustainability impacts of a built environment. In: Horner, M, Hardcastle, C, Price, A and Bebbington, J (Eds.), International Conference on Whole Life Urban Sustainability and its Assessment, 27-29 June, Glasgow, 497-518.

Zhou, L and Lowe, D J (2003) Economic Challenges of Sustainable Construction. In: Proverbs, D (Ed.), COBRA 2003:The International Construction Research Conference of the Royal Institution of Chartered Surveyors, 1-2 September, University of Wolverhampton, 113-26.

7 Acknowledgements

The support of the Engineering and Physical Sciences Research Council (EPSRC) in funding this work is gratefully acknowledged.

Energy profiling in the life-cycle assessment of buildings

Dr Tracey Crosbie, Prof. Nashwan Dawood, Dr John Dean
University of Teesside, UK

Few would deny the centrality of environmental issues to the sustainability agenda. Even a cursory investigation of the existing building environmental assessment methods shows that a building's energy performance is usually a key element in the evaluation process and will constitute a significant portion of the overall assessment result. Thus, increased lifecycle energy efficiency in buildings lies at the heart of most approaches to sustainable urban design, development and assessment. Advances in information and communication technologies [ICTs] offer the opportunity to increase energy efficiency in the built environment by improving the way energy profiling tools and techniques are used to measure and inform the energy performance of buildings throughout their lifecycle. The exploitation of this potential is one of the goals of a current EU FP7 funded project, entitled 'intUBE - Intelligent Use of Buildings' Energy Information. This paper illustrates how the intUBE project will contribute to improving the measurement and evaluation of building energy performance. The paper also highlights the potential offered by the energy profiling tools and techniques being developed as part of the intUBE project to contribute to the assessment of sustainable urban development.

Keywords: assessment, buildings, energy, life-cycle, profiling

1 Introduction

There is much disagreement over the definition of sustainable development. Although there is agreement that sustainable development involves a process which enables the continuing resolution of conflicting priorities – with the ultimate aim of balancing the economic, environmental and social attributes of a particular situation. As no two situations can ever be exactly the same, this process needs to be repeated time and time again and which conflicting priorities are given preference is dependent upon the development context. However, few would deny the centrality of environmental issues to the sustainability agenda and even a cursory investigation of the existing building environmental assessment methods "*shows that a building's energy performance is usually the key element in the evaluation process and will constitute a significant portion of the overall assessment results"* (Hui 2002). Therefore lifecycle energy efficiency in buildings lies at the heart of most approaches to sustainable urban design, development and assessment. Consequently it is unsurprising that there are numerous studies which attempt to assess current and developing benchmarking criteria and buildings codes with reference to how they contribute to sustainable urban development (see for example Hui 2002, 2003; Olgyay and Herdt 2004; Zimmermann et al. 2005; Lee and Burnett 2008). One of the conclusions of this work is that the prescriptive nature of many current approaches to benchmarking criteria and sustainability assessments stultifies innovative approaches to sustainable building design. It is argued that *"[t]o provide greater design flexibility and encourage innovative design, it is important to move towards performance-based approaches and consider the integrated whole building performance in design and evaluation"*(Hui 2002).

Performance-based building energy codes set maximum allowable energy consumption levels without specifying the methods, materials and processes employed to achieve that that level. This approach can be used to allow trade-offs among different aspects of an assessment enabling a combination of measures that yield the best possible performance within certain budgetary constraints to be adopted (Hui 2003). However, performance based approaches to measuring sustainability require a life cycle assessment of the energy demand of buildings which accounts for embodied and operational energy consumption (Erlandsson and Borg 2003; Olgyay and Herdt 2004; Pushkar et al. 2005). In turn, this will demand improvements in the energy profiling tools and techniques used to measure the operational energy performance of buildings and the embodied energy within the materials and methods used in the construction and renovation of buildings.

Advances in information and communication technologies [ICTs] offer the opportunity to improve the way energy profiling tools and techniques are used to measure and inform the energy performance of buildings throughout their lifecycle. The exploitation of this potential is one of the goals of a current EU FP7 funded project, entitled *"intUBE - Intelligent Use of Buildings' Energy Information.* The overall aim of the project is to improve the energy performance of new and existing buildings via the intelligent use of buildings' energy information. It is vital that the tools and techniques developed by this project are not restricted to use in new building projects; as given current demolition rates, it will be necessary to improve the energy efficiency of existing buildings if we are to improve the sustainability of the built environment with any kind of propinquity.

Redeveloping rundown buildings can be more sustainable than demolishing them, as reuse reduces both the amount of embodied energy wasted through demolishing a building, and the (potential) energy used in constructing new ones.

Nonetheless, the energy used in running a building throughout its life cycle is much greater than that used in its construction. Therefore, if building redevelopment is to be thought of as a sustainable practice, renovation and refurbishment programmes must seek to bring about ever more energy efficient buildings.

The reminder of this paper illustrates the potential of the intUBE project to contribute to improving the measurement and evaluation of building energy performance during the whole lifecycle of buildings. To do so the main body of the paper is divided into three sections. The first introduces the reader to how energy profiling is used within the built environment and the potential provided by new ICTs for improving the lifecycle assessment of buildings. The second section outlines the approaches to energy profiling adopted within the intUBE project. By way of conclusion the final section of the paper highlights the potential offered by the energy profiling tools and techniques being developed within the intUBE project to contribute to the assessment of sustainable urban development.

2 Energy profiling in the lifecycle assessment of buildings

2.1 What is energy profiling?

Energy profiling, in the built environment, involves an analysis of the actual or predicted energy performance of buildings and/or an analysis of the embodied energy within the materials and methods used to construct buildings. The ultimate aim of this analysis is to improve the energy performance of buildings. Energy profiling usually involves comparisons between actual or predicted energy use and some type of benchmark or model intended to indicate regulatory requirements, average energy consumption or best practice. The focus of energy profiling can be individual buildings (Doukas et al. 2007), building types (Huang et al. 1991; Gaglia et al. 2007; Räsänen et al. 2008), organisations (Levermore 2000; Ó Gallachóir et al. 2007) or localities (Jaccard et al. 1997; Yao and Steemers 2005; Yamaguchi et al. 2007; Heiple and Sailor 2008). Energy profiling often involves calculations of both energy consumption and related carbon dioxide (CO2) emissions (Jaccard et al. 1997; Myer and Chaffee 1997). This approach is related to increasing environmental concerns which have brought about new government regulations associated with the assessment of the energy performance of buildings in many countries (Levine et al. 2007). This new regulatory environment combined with rising energy prices is stimulating a new interest in the role of energy profiling in measuring and optimising energy performance during the whole life cycle of domestic and commercial buildings (O'Donnell et al. 2004).

2.2 How is energy profiling applied?

2.2.1 The traditional approach

Traditionally two types of energy profiling are used in different phases of a buildings lifecycle. These can be thought of as design-phase energy profiling and operational-phase energy profiling. The former usually involves building energy simulations. It is conducted by design professionals (project team members, assisted by energy consultants) using building design and energy analysis software tools to analyse the energy performance of their designs. For example, the energy performance feedback provided by whole building energy analysis tools allows designers to assure equipment is properly sized for the design conditions of a given building and that the part-load performance of the building subsystems are optimised to provide a comfortable environment with the lowest possible energy costs (Jacobs and Henderson 2002). Design phase energy profiling could also include calculations of the embodied energy within the products and methods used in the construction of buildings, although this type of energy profiling in buildings is very poorly represented in current preconstruction energy analysis (Hellingsworth 2002).

Ideally operational-phase energy profiling is based on the actual energy consumption of the building or buildings under examination. It is used to analyse buildings energy demand and illustrate measures that building managers, owners or occupiers can use to improve energy efficiency within the running of those buildings on a daily basis. However much energy analysis for the operational phase of a buildings life cycle has been sporadic, typically working from historical metered data and focusing on bulk energy assessment (O'Donnell et al. 2004). This level of information leaves many possibilities for the reduction of heavily energy intensive energy consuming practices in both commercial and domestic buildings unknown. It also means that much of the information which is used to assess building energy performance is based on 'rules of thumb' rather than the measurement of that performance (Hand et al. 2008).

2.3 New technologies and new possibilities

Advances in the sophistication of computing technologies and real-time monitoring and metering technologies, combined with a reduction in their cost, offer the possibility of improving the information used in assessments of building energy performance. These technologies are enabling a rapid growth in the sophistication of energy profiling and encouraging an expansion of the use of building management systems (BMS) to manage the energy consumption of buildings. BMS are control systems for individual buildings or groups of buildings that use computers and microprocessors for monitoring, data storage and communication (Levermore 2000). BMS can be centrally located and communicate over telephone or Internet, with remote buildings having 'outstations' so that one energy manager can manage many buildings remotely. With energy meters and temperature, occupancy and lighting sensors connected to a BMS, faults can be detected manually or automated fault detection software can be used to avoid energy waste (Levine et al. 2007). With the advent of inexpensive, wireless sensors and advances in information technology, extensive monitoring via the Internet is possible (Clarke et al. 2004).

Advances in computing technologies are also facilitating improved techniques within design phase energy profiling. For example, new building information modelling software tools and techniques are enabling the creation and use of coordinated, internally consistent, computable information about a building. However the building information models [BIMs] produced are criticised for not explicitly incorporating feedback to the design phase of buildings or accounting for any changes made to buildings layout or fabric during construction(O'Donnell et al. 2004). In the absence of accurate data obtained from actual buildings in operation, designers need to rely on estimate values to feed in the data about loads, air flows, or heat transfer in order to carry out energy simulations (Hand et al. 2008). It is therefore suggested that BMS can be integrated with the building energy analysis software tools traditionally used in the design phase of buildings to enable BIMs to act as a data source which can be compared against actual building energy performance (O'Donnell et al. 2004). This would represent a dramatic move forward within energy profiling as it would enable architects, planners, building managers, consumers and owners to accurately visualise both the measured and predicted energy performance of a building. Interoperable performance analysis software tools capable of integrating the information stored in BMS with whole building energy simulation tools capable of emulating the building dynamic behaviour are under development (O'Donnell et al. 2004). There is also progress in this area in software tools designed for the domestic environment (Mills 2004; CSIRO 2008) which ultimately could enable 'smart neighbourhoods' that utilise design-phase and operational phase energy profiling to enable optimum energy use across a given community or local.

3 IntUBE and the future of energy profiling

3.1.1 The vision and the challenges

The intUBE project is developing new methods of integrating the ICTs used in the design and operation of buildings with the aim of facilitating improvements in the energy performance of buildings and the measurement of that performance. To do so, the project will develop new methods and tools which integrate design phase and operational phase energy profiling. The potential of this approach for supporting performance based energy assessments is great, as it could significantly improve the way in which the energy performance of buildings is assessed. However research has shown that there are many barriers to the adoption of the energy profiling software tools designed for professional use. This is problematic because a more generalised uptake of these tools is essential to improving the measurement and evaluation of building energy performance.

Barriers to the adoption of energy profiling software tools include the steep learning curve required to enable the use of energy simulation tools and the extensive data input required by those tools (Jacobs and Henderson 2002). The amount of time necessary for data entry when using energy analysis programs is repeatedly mentioned by researchers as one of the main obstacles to the generalised use of these tools (Bazjanac 2003, Neuberg et al. 2003, Hand et al. 2008, Laine et al. 2007, Klein et al. 2008). Poor interoperability between building information models and energy simulation tools also hinders a generalized use of energy analysis (Krygiel and Nies, 2008). Currently, the time required to process the geometry generated with a BIM authoring tool to conform to the format required by an energy analysis software amounts to up to 50% of the time a project team dedicates to performing energy simulations (Krygiel and Nies, 2008). The lack of accurate real-time consumption information on which to base energy simulations is also a barrier to the use of energy profiling in both the operational phase and design phase of buildings (O' Donnell 2004). While the level of expertise necessary to interpret the results of energy simulations is a further obstacle to the use of energy profiling in the design and operation of buildings (Schlueter and Thesseling 2008).

3.1.2 The way forward

The problems outlined above have lead to the infrequent application of comprehensive energy profiling in the design and/ or operation of buildings (Jacobs and Henderson 2002). Therefore it is important that the energy profiling tools and techniques developed within the intUBE project ameliorate as many of these issues as possible. To do so new approaches to the following are being developed:

- The integration of BIM authoring software and energy simulation software;
- The integration of simulation and real-time data capturing sensors;
- Evaluating and selecting amongst the design alternatives offered by energy simulation software.

In this way techniques and tools developed as part of the intUBE project should overcome many of the barriers to the generalised use of energy profiling as earlier research suggests that:

- By integrating BIM authoring software with energy simulation software much of the time taken to enter data into energy simulation software could be eliminated (Krygiel and Nies, 2008).
- By integrating simulation tools and real-time data capturing sensors within buildings the data on which energy simulations are based could be greatly improved, as could the accuracy of the energy profiles used to inform building operation (O' Donnell 2004). This approach also offers the opportunity to use real-time information about buildings to optimise building operation (Packham et al 2008).
- By providing a method of evaluating and choosing between the design alternatives offered by energy simulation tools the uptake of their use could be greatly improved (Schlueter and Thesseling 2008).

3.1.3 The philosophy of the intUBE approach

The first stage in producing simulated energy models or profiles of any given building is the development of a building information model [BIM] for that building. Essentially a BIM is coordinated, consistent, computable information about a building stored in a single data repository. A BIM can represent an existing building or a building which is at the design stage. However, standard BIMs do not contain all of the data necessary for simulating energy use in a building. Therefore it will be necessary to combine the data from a buildings' BIM with additional information, such as building use, HVAC system details, building spaces and occupancy levels, to create an Energy BIM. This process will enable the production of detailed simulated energy profiles for a building. These simulations of a buildings' energy performance will then be analysed to identify design strategies and/ or building control strategies. This information will then be stored in a relational database creating a reference model of simulated building and systems performance (See figure 1).

In process A 1 the BIM is developed and the data necessary for conducting energy simulations is added to create an Energy BIM. In process A2 the energy simulations are conducted based on historical weather data. In process A3 the energy simulations are analysed to identify optimum building design/building control strategies which are then used to create the reference model in process A4

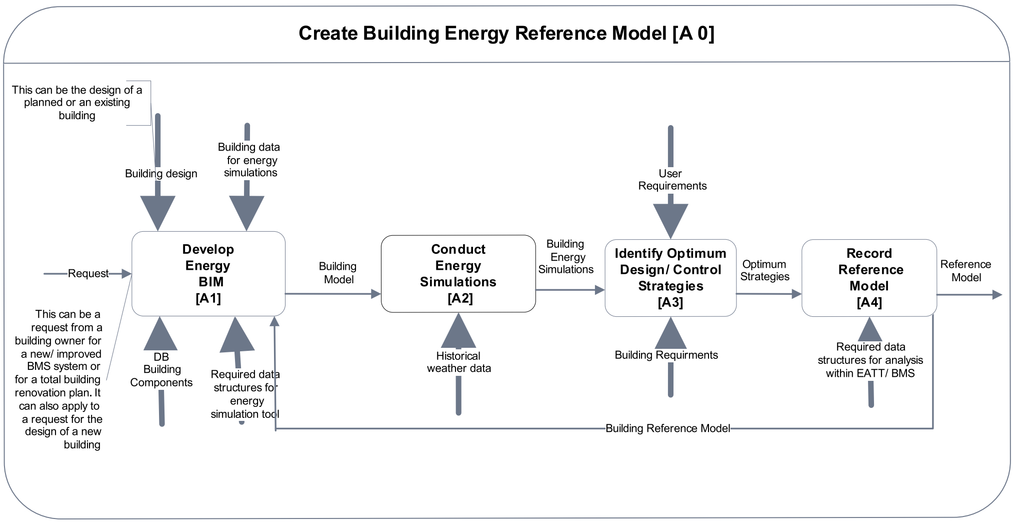


Figure 1 Create building energy reference model

At the design stage of a buildings lifecycle [or at the redesign stage in the case of building renovation] the reference model will be used to draw comparisons between different design alternatives. The system will include an environmental assessment trade-off tool [EATT] which will enable the choices necessary to the optimisation of building energy performance to be made at the early stages of the design process (See figure 2). This is highly advantageous because it is at the early stages of design that the greatest opportunity for cost-effective energy measures occurs (Schlueter and Thesseling 2008). The EATT tool will use a lifecycle cost assessment, a lifecycle assessment of the embodied energy used within building construction /renovation and an assessment of the energy performance of the building. Multi-criteria decision analysis (MCDA) theory, also known as multi-criteria decision making (MCDM), will be used to explore the trade-offs between different variables and to address their impact on the overall design of the building (See figure 2 and Loh et al 2008 and Loh et al forthcoming). The output of this stage will be a building model which illustrates the most energy efficient building design or renovation plan possible within given constraints. This building model will form the basis of a building reference model which can then be extended to inform building operation once the construction/ renovation process is complete.

The Lifecycle Assessment [LCA] will be conducted by a software tool, such as SimaPro (See SimaPro 2008), which enables the measurement of the energy embodied within the life cycle of the construction materials to be measured, as well as the energy embodied within the construction methods.

The Environmental Impact Analysis [EIA] and the Lifecycle Cost Assessment (LCCA) will be conducted by a tool such as Integrated Environmental Solutions (IES) VE-WARE (See IES 2008). The LCCA will include capital build cost and annual maintenance and running costs, while the EIA will include energy use and CO_2 emissions.

The results from EIA, LCA and LCCA assessments will be input into the Environmental Assessment Trade-off Tool (EATT) which will enable design decisions to be made with full comprehension of both the upside and downside of a particular choice with regard to CO_2 emissions, energy consumption, build costs and running costs.

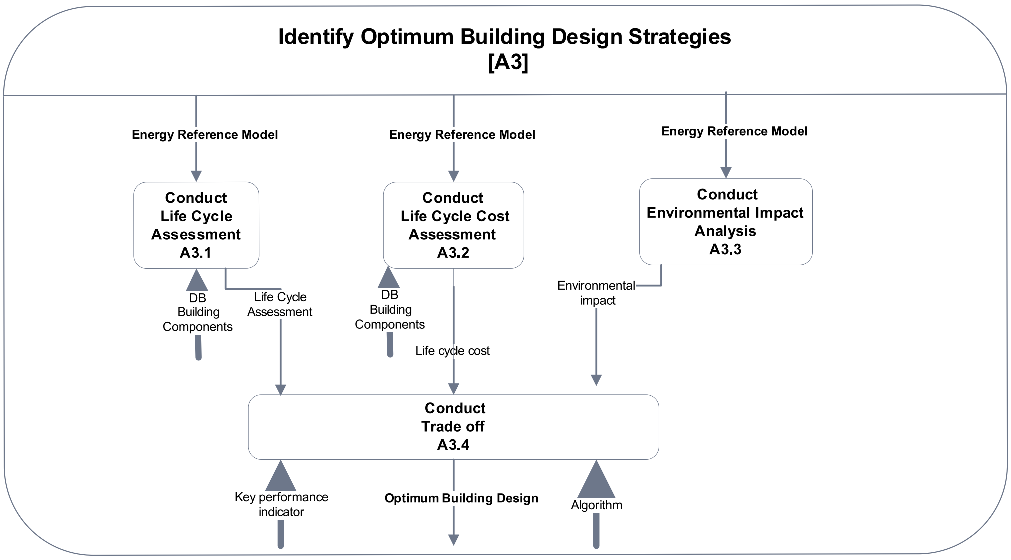


Figure 2 Identify Optimum Building Design Strategies

The reference model used to inform building operation will be more detailed than that used during design stage energy profiling. This is because it will be necessary to model the buildings control system in much more detail than is the case during the design phase of buildings. Therefore in the case of buildings which were modelled during their design further building information will have to be added to the reference model. In the case of existing building which are being renovated the reference model will have to be developed from scratch. During the operational phase of a building the reference model will provide a data resource which will be used to support the intelligent control of a buildings' management system (See figure 3). The intelligent control of a buildings' management system will be achieved by using the optimum building control strategies within the reference model to inform building control. It will also be possible, to further tailor building control. This will be achieved by using the information concerning a buildings simulated thermodynamics and simulated response to HVAC etc, to train various computationally intelligent algorithms and send control decisions back via the BMS that take into account ambient weather conditions and building occupancy. In this way the energy profiling system developed will enable the building management system to optimise building energy performance while maintaining the thermal comfort of the buildings occupants.

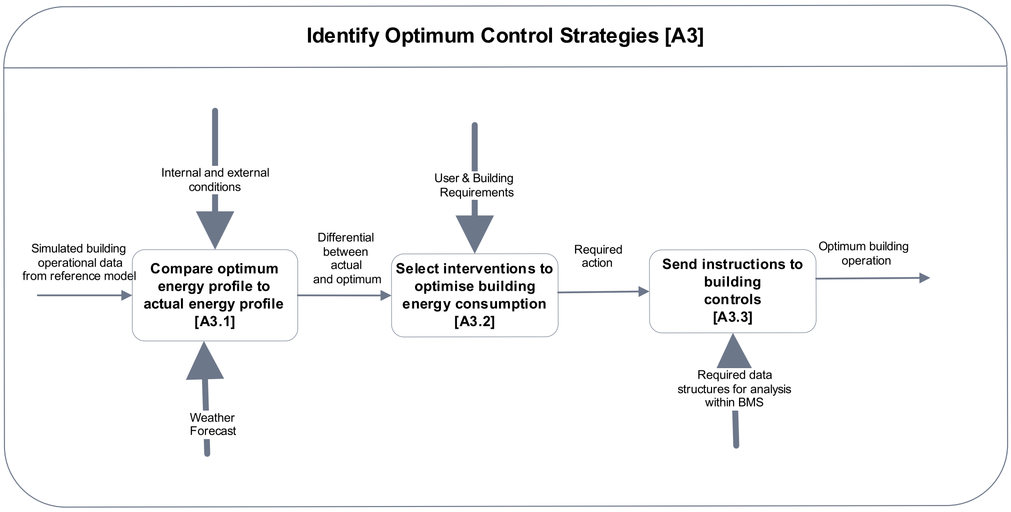


Figure 3 Identify Optimum Control Strategies

Conclusions

The intUBE project will contribute to *"[t]he long-term vision held by many in the building science community: virtual (collaborative) 'life-cycle' building tools that simulate actual buildings and their construction coupled with intelligent systems that monitor and archive design intent and performance and feed the results back to the simulation tools, which, in turn, grow more refined through integrating better empirical data"*(Mills 2004). The potential offered by this approach to contribute to the assessment of sustainable urban development is great. Firstly the tools and techniques described in this paper will enable those involved in the design of buildings, or developing renovation plans to accurately measure the energy performance of their designs and renovation proposals. In doing so the necessary information for adhering to performance based energy codes will be provided. Secondly the approach adopted also offers the opportunity to inform performance based energy codes by improving the building energy performance data on which they are based. Thirdly the tools and techniques described in this paper provide a method of evaluating and choosing between the design alternatives offered by energy simulation tools which could be used to simplify the compliance process once performance based energy codes have been developed and implemented.

4 References

Bazjanac, V. (2003) Improving building energy performance simulation with software interoperability, Eighth International IBPSA Conference, Eindhoven

Clarke, J.A., Johnson, C., Kim, J. M., and Strachan, P. A. (2002) On-line energy services for smart homes, in Proceedings of EPIC 02 Conference, Air Infiltration and Ventilation Centre, see http://www.esru.strath.ac.uk/Documents/02_EPIC_SH.pdf

CSIRO, (2008) Profile Project: Energy management by linked local controllers, see http://www.csiro.au/science/IntelligentEnergyControllers.html#smart

Doukas, H. Patlitzianas, K. D., Iatropoulos, K., and Psarras, J. (2007) Intelligent building energy management system using rule sets, Building and Environment, 42 (10):3562-3569

Erlandsson, M. and Borg, M. (2003) Generic LCA-methodology applicable for buildings, constructions and operation services – today practice and development needs. Building and Environment, 38(7):919-938

Gaglia, A.G., Balaras, C.A., Mirasgedis, S., Georgopoulou, E., Sarafidis, Y. and Lalas, D.P., (2007), Empirical assessment of the Hellenic non-residential building stock, energy consumption, emissions and potential energy savings, Energy Conversion and Management, 48(4): 1160-1175

Hand, J.W, Crawley, D. B., Don, M., Lawrie, L. K. (2008) Improving non-geometric data available to simulation programs, Building and Environment, 43:674-685

Heiple, S. and Sailor, D., J., (2008) Using building energy simulation and geospatial modeling techniques to determine high resolution building sector energy consumption profiles. Energy and Buildings, 40(8):1426-1436

Hellingsworth, B. Best, R., de Valence, G., (2002), Design and Construction: Building in Value, Butterworth-Heinemann.

Huang, Akbari, J. H., Rainer, L., and Ritschard, R., (1991), 481 Prototypical commercial buildings for 20 urban market areas, in DOE Project: United States

Hui, S. C. M., (2002), Environmental sustainability assessment of buildings using requirements in building energy codes, Sustainable Building 2002 International Conference, 23-25 September, Oslo, Norway, see http://www.arch.hku.hk/~cmhui/sb2002-cmhui.pdf

Hui, S. M. C. (2003) Energy Efficiency and Environmental Assessment for Buildings in Hong Kong, presented at MECM LEO Seminar – Advances on Energy Efficiency and Sustainability in Buildings, 21-22 January, Palace of the Golden Horses, Kuala Lumpur, Malaysia, See http://www.arch.hku.hk/~cmhui/MECM-LEO_Seminar-samhui_paper.pdf

IES (2008) Integrated Environmental Solutions VE-WARE, accessed at http://www.iesve.com/content/default.asp?page=s130 [7th Jan 2008]

Jaccard, M., Failing, L., and Berry, T. (1997) From equipment to infrastructure: community energy management and greenhouse gas emission reduction, Energy Policy, 25(13): 1065-1074

Jacobs, P. and Henderson, H. (2002) State-of-the-art review whole building, building envelope, and HVAC component and system simulation and design tools, Architectural Energy Corporation

Klein, R., Versele, A., Breesch, H. (2008) 'Using Building Information Models for Passivehouses: Benefits and future developments', 12th International Conference On Passive Houses, Exhibition Centre Nuremberg, 11th and 12th April.

Krygiel, E. Nies B., (2008) Green BIM: Successful sustainable design with building information modelling. Indianapolis: Wiley Publishing.

Laine, T., Hänninen, R., Karola, A. (2007) Benefits of BIM In The Thermal Performance Management, Proceedings of Building Simulation Conference.

Lee, W. L. And Burnett, J.(2008) Benchmarking energy use assessment of HK-BEAM, BREEAM and LEED, Building and Environment 43(11):1882-1891.

Levermore, G. (2000) Building Energy Management Systems - An Application to Heating, Natural Ventilation, Lighting and Occupant Satisfaction: Master eBook

Levine, M., D., Ürge-Vorsatz, K., Blok, l., Geng, D., Harvey, S., Lang, G., Levermore, A., Mongameli Mehlwana, S., Mirasgedis, A., Novikova, J., Rilling, H., and Yoshino, J., (2007), Residential and commercial buildings, in Climate Change: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, and L.A. Meyer, Editors, Cambridge University Press: Cambridge, United Kingdom and New York

Loh, E., Dawood, N., and Dean, J. (2008) Development of framework for 3D-Environmental Assessment trade-off tool (3D-EATT), paper proceeding for 8th CONVR International Conference, 20th - 21st Oct, Kuala Lumpur, Malaysia

Loh, E., Crosbie, T., Dawood, N., and Dean, J. (Forthcoming) Development of trade-off algorithm with AHP-GA for building lifecycle cost and Environment Impact Assessment, SUE-MoT Conference, 2nd International Conference on Whole Life Urban Sustainability and its assessment, 22nd-24th April, Loughborough, UK

Mills, E. (2004) Inter-comparison of North American residential energy analysis tools, Energy and Buildings, 36(9):865-880

Myer, A. and Chaffee, C., (1997), Life-cycle analysis for design of the Sydney Olympic Stadium, Renewable Energy, World Renewable Energy Congress IV Renewable Energy, Energy Efficiency and the Environment, 10(2-3):169-172.

Neuberg, F., Rank, E., Ekkerlein, C., Faulstich, M. (2003) Integrated Life Cycle Assessment for a Sustainable Resource Management of Buildings' in Proceedings of the Eighth International IBPSA Conference Eindhoven, Netherlands August 11-14

Ó Gallachóir, B.P., Keane, M., Morrissey, E., and O'Donnell, J., (2007), Using indicators to profile energy consumption and to inform energy policy in a university--A case study in Ireland, Energy and Buildings, 39 (8):913-922.

O'Donnell, J., Morrissey, E., Keane, M., and Bazjanac, V. (2004), BuildingPI: A future tool for building life cycle analysis, SimBuild, Boulder, Co August 4-6, United States

Olgyay, V., and Herdt, J. (2004) The application of ecosystems services criteria for green building assessment, Solar Energy, The American Solar Energy Society's Solar 2003 Special Issue 77(4): 389-398

Pushkar, S., Becker, R. and Katz, S. (2005) A methodology for design of environmentally optimal buildings by variable grouping, Building and Environment 40(8): 1126-1139.

Räsänen, T., Ruuskanen, J., and Kolehmainen, M. (2008) Reducing energy consumption by using self-organizing maps to create more personalized electricity use information, Applied Energy. 85(9):830-840

Schlueter, A., Thesseling, F. (2008) Building information model based energy/exergy performance assessment in early design stages, Automation in Construction, doi:10.1016/J.autcon. 2008.07.03

SimaPro (2008) SimaPro LCA software, accessed at http://www.pre.nl/simapro/ [Jan 7th 2009]

Yamaguchi, Y., Shimoda, Y., and Mizuno, M. (2007) Proposal of a modeling approach considering urban form for evaluation of city level energy management, Energy and Buildings, 39(5): 580-592

Yao, R., and Steemers, K. (2005) A method of formulating energy load profile for domestic buildings in the UK. Energy and Buildings, 37(6): 663-671

Zimmermann, M., H., Althaus, J., and Haas, A. (2005) Benchmarks for sustainable construction: A contribution to develop a standard. Energy and Buildings, Research That Inspires 125 Years of EMPA 37(11): 1147-1157

5 Acknowledgements

The research presented in this paper is part of the work of an EU FP7 funded project entitled *"intUBE - Intelligent Use of Buildings' Energy Information.* The IntUBE consortium spans key research partners from Northern to Southern Europe including SMEs. For further information see http://www.intube.eu/

Daylight simulation for sustainable urban office building design in Dhaka, Bangladesh: decision-making for internal blind configurations

Ashikur Rahman Joarder[1], Prof. Zebun Nasreen Ahmed[2], Prof. Andrew Price[1], Dr Monjur Mourshed[1]

1 – Loughborough University, UK

2 – Bangladesh University of Engineering and Technology, Bangladesh

In an urban site, daylight strategies increasingly depend on the availability of natural light, which is influenced largely by the immediate surroundings of the building, particularly the presence of natural and manmade obstructions. Under such conditions the latitude of the site and its regional climatic conditions, such as ambient outdoor daylight levels and sunshine probability are found to have diminished direct impacts on the interior daylight potential. In these highly specific urban environments created by built-up surroundings, no generalised way exists to describe or predict the luminous microclimate. However, simulation can be used as a design tool for sustainable daylight design. Using simulation programs, this paper examines the significant impact of surroundings on daylight probability on urban buildings. Daylight simulation was performed in this study by creating the virtual urban environment based on the information of a true site urban office building in Dhaka, Bangladesh, a tropical location, with predominantly overcast skies. The 3D models were first generated for computer simulation in the Ecotect program to calculate the amount of daylight incident on a generated grid point on the work-plane. These models were then exported to Radiance Synthetic Imaging software to generate realistic lighting levels and finally verified with DAYSIM simulation program for annual performance evaluation. The results show that daylight entering from different sides of the building is affected vastly by surroundings and this influences the indoor illuminance and luminance distribution. This paper also demonstrates a case of decision-making between two most popular configurations (vertical and horizontal) of internal blinds used in urban offices of Dhaka. The focus of the paper is to highlight the importance of daylight simulation in sustainable urban office building design, while at the same time gives a general methodology for decision-making regarding daylight design elements.

Keywords: daylight simulation, decision making, internal blind configurations, sustainable design, urban office building

1 Introduction

The elements and components of urban landscape affect the local climate and generate the microclimate of the area which may differ from regional climate. This is truer for the visual environment (Baker et al. 2002) and from view of the sustainable daylight potential in a space. In a dense urban area, indoor daylight potential depends more on the immediate surrounding conditions of the building, e.g., density of built environment, building type, building height, location of floor in the building, orientation, material used for construction, the presence of obstructions and trees etc. and comparatively less on the geographical regional climate, latitude of the building site, ambient outdoor daylight levels, sunshine hours and other such general parameters. In such situations, the daylight potential of an urban site may differ from neighbouring sites being influenced by the immediate surroundings.

Daylight simulation can be used to predict the actual daylight levels in critical periods of the year and also can be used as a design tool, during the decision-making process of the different design elements in any building. Daylight simulation as a design tool could be extremely useful in urban areas, where changes occur frequently due to the densification of the built environment, increasing building proximity, in which case buildings and other structures act as barriers or reflectors, either casting shadows or reflecting daylight into a space. Daylight simulation can also help the architects and designers to choose the energy-efficient and sustainable options available. This paper consists of major two parts. The first part describes the importance of daylight and simulation tools for sustainable building design with an example of an urban office building. The second part presents a demonstration of simulation analysis to make a decision for a particular building element design (internal blind configurations) considering daylighting potential for the same building. It is expected that the examples of daylight simulation presented in this paper will help designers to comprehend the significance of simulation tools for sustainable building design in urban sites.

2 Importance of Daylighting for Sustainable Office Building Design

Daylight is the most abundant source of light that is available to us for the most important strategy for energy savings in buildings (Phillips 2004). The question of daylight inclusion for sustainable office buildings is extremely important, because being day-use buildings, a significant portion of the period of use of these buildings coincides with times when outdoor lighting is substantial. Using this light, dependence on artificial lighting sources can be minimised, resulting in energy efficient sustainable buildings. These issues are all the more important in the tropics which are endowed with an abundance of daylight.

In an urban area, where the demand of electricity is very high, reduction of energy use for lighting purposes by using daylight is the key to sustainable building design in the city. Electric lighting energy use can be reduced by 25-50% with advanced light sources, design strategies and controls, and by 75% with the addition of daylighting (Clanton et al., 2004).If daylight penetration is not given due consideration by the designer while locating and selecting size of windows, interior surfaces, lighting fixtures, etc. pressure will be created on the overall national energy demand. In such a context, the need to develop use of daylight in urban office buildings, reducing dependence on artificial light, is necessary to save energy, which is extremely limited. Furthermore, in cities like Dhaka, beset by load-shedding and electricity interruptions, inmates of buildings regularly need to depend solely on daylighting, making it a prime consideration for adequate visual performance.

On a more personal level, without sufficient daylight circadian rhythms can be affected which results into depression, seasonal affective disorder (SAD), insomnia, and other mood and sleep disorders (Joarder et al., 2009). Individuals' biological need for lighting are different from visual lighting need, and lack of adequate light for biological stimulation can lead to health problems (Begeman et al. 1997). Only the natural light provides the complete spectral energy distribution essential for all of the biological functions. As people work in offices during daytime, they are more vulnerable to affected by lack of sunlight needed in 24 hour. The disturbances in circadian rhythm is more prominent to an individuals who lives at low latitude levels (the tropics) and working in poorly daylit buildings (Baker 2008) such as, in deep plan air-conditioned buildings, which are predominantly artificially lit. The phase synchronising ability of light is found dependent on its intensity, and on the time of day that the subject is exposed – morning being the favourable part of the day. The facility for occupants of a building to be close enough to a window to receive high levels of illuminance – in excess of 1000 lux – is rarely experienced in artificial lighting. This fact makes demands on the planning and detailed facade design, as well as the management of space.

In today's age of competition, the office worker needs to spend much more time indoors doing office work than ever in the past. Estimation for instance, shows that Americans spend more than 90% of their time indoors (S.D.I.C. 2008) and this trend is catching up in the developing nations. This significantly increases exposure of the inmate to pollutants, adversely affecting health, and to poorly designed lighting. This latter can result in eye strain, headaches, and higher than average work errors, which decreases productivity and product quality. Too much or too little light — or lighting that is not designed for the tasks at hand — actually can impair worker vision or make it more difficult to get the job done right. The Centre for Building Performance and Diagnostics (CBPD) has identified twelve international case studies that indicate that improved lighting design increases individual productivity between 0.7-23% while reducing annual energy loads by 27-88% (Loftness et al., 2006). Therefore lighting is considered to be one of the key issues to be addressed for sustainable office designs.

3 Why Daylighting is critical in Urban Sites

The loss of daylight, sunlight and solar gain due to obstructions is an important feature of urban areas (Littlefair 2001). Tall buildings and other obstructions close by can affect the distribution of daylight in a building and reduce the total amount received. The urban site can pose constraints on the choice of built form, which will influence the possibilities for optimising the daylighting. The shape and size of the site generally influences the shape of the building, particularly in dense urban situations. Legislation and planning codes may also impose further restrictions on building form. The microclimate of an urban area can be very different from its surrounding regional climate.

Daylight is one of the most important natural forces available to architects in their quest to enhance the visual quality of interior spaces (Ahmed & Joarder 2007). Though we assume it to be available and ubiquitous almost everywhere in world, being especially abundant in the tropics, nevertheless, unplanned and haphazard growth of urban areas may make a building site critical in terms of daylight availability, due to the impact of surrounding structures.

In commercial zones, as land prices are high (Ahmed 1997), the buildings become taller and the density of buildings attain higher levels in these areas, in comparison to other areas of the city. This causes the impact of one building on another to have greater significance in commercial urban areas, and in most cases it becomes difficult to draw in daylight from the sides of buildings, even with full-height glass windows. Moreover, under dense conditions, over-glazing can also create problems of privacy from neighbour buildings, consequently limiting window size.

4 Consideration of Daylighting in Urban Sites

Decisions about daylight designing in an area depends on a building's location and site characteristics; e.g. whether in a green field or urban situation. These decisions take into account, among other considerations, the orientation, the sun path and location of existing buildings or landscape (Phillips 2004).

Among the site considerations for daylight designing in an urban area, the key issues are: understanding the impact of present and future natural and manmade surroundings on the availability of interior daylight of the proposed building and the protection of future buildings from the shade of the proposed building (Fontoynont et al. 2004). So, daylight design for a building in a dense urban site should ensure that daylight is available both in the interior and on the exterior of the building, without compromising the lighting rights of adjacent existing or future buildings. Studying both climate and daylight availability at a construction site is key to understanding the operating conditions of the building's facade (I.E.A. 2000).

The obstruction to the sun and sky from terrain and other buildings has a very important influence on daylight potential in urban buildings. In standard daylight analysis it is customary to assume that obstructions have brightness (luminance) that is only 1/10 of the brightness of the unobstructed sky. The daylight contribution from the shaded part of the sky vault is thus reduced by 90% (Baker et al. 2002). So, along with the size and shape of a window, the daylight potential of an urban office building also depends on whether the window is obscured by surrounding buildings, and how much of the floor area has an un-obscured view of the sky. All these and other considerations need to be taken into account if an accurate calculation of the overall daylight picture is to be made. In designing a new development or extension to a building, the safeguarding of the daylight to nearby buildings is very important. A badly planned development may make adjoining properties gloomy and unattractive (Littlefair 2001).

5 Application of Daylight simulation for Urban Buildings

To be successful, daylighting requires the integration of all major building systems. Daylighting issues should be well-defined in the programmatic or schematic phases of design and monitored through construction to occupancy. Early planning is essential, since it may be difficult and costly to add features later in design development, and may even compromise other requirements if added as an afterthought. In designs that push the state of art, present unusual conditions, or have quantitative performance expectations that must be met, it may be appropriate to use many of the computer-based simulation tools now available.

In built-up dense urban environments, windows on lower floors of office buildings, adjacent to multi-story buildings will receive inadequate daylight, due largely to sky obstruction. However, the south facade of a light coloured building that is exposed to direct sunlight can become a very bright light source for the north facing windows of an adjacent office building (A.G.S. 2000). As such situations are highly specific to the time of day and to the particular geometry of the buildings, no generalised way exists to describe or predict this luminous microclimate. However, simulation techniques can be used to evaluate particular cases (Baker et al. 2002). In reality, due to the simultaneous influence of many different conditions, it is difficult to isolate the exclusive effect of one single aspect, or its variations. Daylight simulation can be a very effective and useful means to study the effect of changes in any particular aspect, keeping other aspects constant.

With the advent of personal computers (PCs) and powerful processors that can handle complex calculation algorithms, nowadays lighting simulation techniques are available to nearly all researchers. Since 1980s, new software have been developed to address the complexity of light propagation into building spaces in addition to the first generation of simple design tools based on numerical programmes. More complex software has been developed by researchers for mainframe computers. Limitations have been overcome by simple tools to address the geometry and the photometry of the modelled 3D space with richer graphic output options (e.g., illuminance contours and mapping). Image-based daylighting programming have improved the output features by providing synthetic imaging of modelled spaces. The handy and user-friendly tools now have ability to allow importing files of different types, so as to minimise, or even reduce the background work needed to define the proposed 'simulation space' with its design features.

In recognition of the importance of window detailing to the penetration of light into large office spaces in tight urban situations, computer simulation was undertaken (Joarder 2007) exploring various window details, of which variations of blind configuration is described in this paper. For the purpose, two PC version simulation programs were used to investigate and analyse the impact of building surroundings and different internal blind configurations that are commonly used in Dhaka, on consequent indoor daylight distribution. The first one is a comprehensive and innovative building analysis software Ecotect v5.20 which is a highly visual architectural and analysis tool (Crawley et al, 2005) with lighting, thermal, energy, shading and acoustic performance analysis functions (Osaji et al, 2009), the second a more focused and accurate daylighting simulation tool, Desktop Radiance 1.02 (Baker, N. et al., 2002; Ward, 1994).

6 Selection of Site and Building for Simulation Study

The climatic characteristics of Dhaka City differ from other cities of the country due to its location and rapid physical development in last few decades. Again within the same city these characteristics are further modified in different locations. This is due to the density of built environment, building type, building height and their orientations, proximity between buildings, surface quality of the area – hard or soft, materials used for construction, and other related factors.

The criteria for site and building selection was that it should be in an urban context with different exterior conditions on four different sides (Figure 3, 4 & 5). This would permit isolating, through simulation, the effects of surroundings and different internal blind configurations on interior daylighting quality, quantity and distribution. According to the above criteria the nine storey Opsonin Building (corporate office of Opsonin Pharma Ltd.) was selected for examination and simulation study (Figure 1).

7 The Simulation

The selected building was used for two simulation studies. Both the positive and negative impacts of building surroundings in an urban area can be identified by comparing the true-site building model with the same building placed on a vacant field. So, in the first stage, to highlight the impact of the surroundings on interior daylight distribution at work plane height, two models of the same space were compared, one with the surroundings found during physical survey and the other with no surrounding obstructions, as if placed on a vacant field.

During the physical survey it was identified that internal blinds have a significant impact on incident daylight and in combination with a glazed window it acts as a visual screen or filter between interior and exterior. So, in the second stage, simulation was done considering the true urban building surroundings, to decide between the two popular configurations of internal blinds found in Dhaka city (Joarder, 2007), aiming to achieve quality daylight at work plane height.

Figure 1: Location of nine-storey Opsonin Building in urban setting of Dhaka

8 Performance Evaluation Process

For the purpose of the simulation, the entire office space was divided into grids with reference to column-structural grid (Figure 2). Then 83 points in the open office space were selected for recording of daylight levels at 0.75m above floor level, representing the work plane height for offices in Dhaka (Joarder 2007). Each intersection point of the grid was coded according to the number-letter system shown in Figure 2 and the values of the points were included in all the later Tables (Tables 1, 2, 3 & 4). To guide the reader's eye, points have values higher than 300 lux are shown in italic, points have values within acceptable range (300-900 lux) are shown in italic bold and points on XX' and YY' axes are shaded on the tables.

Daylight simulation was done using Ecotect for these grid points to find predicted daylight levels first (Appendix A, B, C & D). The simulated illumination values were then plotted into Tables with the codes coinciding with intersection of letters (rows) and numbers (columns). These values were then compared for different situation results. Two additional axes XX' & YY' (Figure 2) across the plan show the fluctuation of the daylight levels from the window towards the opposite face (Figures 2 & 3). The calculations consider the daylight factor concept, the constant ratio valid only under overcast sky conditions in the absence of direct sunlight (Koenigsberger et al. 1997). This is the assumed characteristic of Dhaka's skies during much of the year.

The 3D models were first generated for computer simulation in the Ecotect program to calculate the amount of daylight incident on each grid point on the work-plane. In case of critical decision-making these models were exported to Radiance Synthetic Imaging software to generate realistic predictions of lighting levels. For Desktop Radiance an additional imaginary horizontal plane 0.75m above floor level was generated to show daylight contour map on work plane height (Figure 10). Finally a performance metrics was done with DAYSIM 2.1.P4 simulation program to get a complete annual picture.

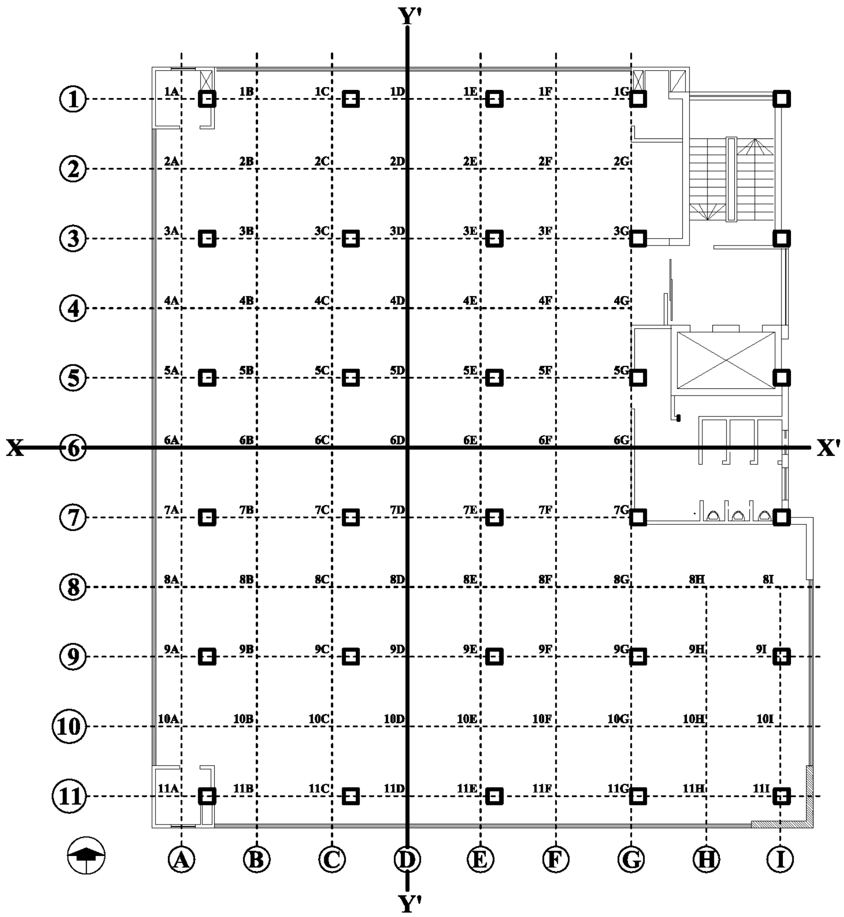


Figure 2: Plan showing the column/structural grid with node references.

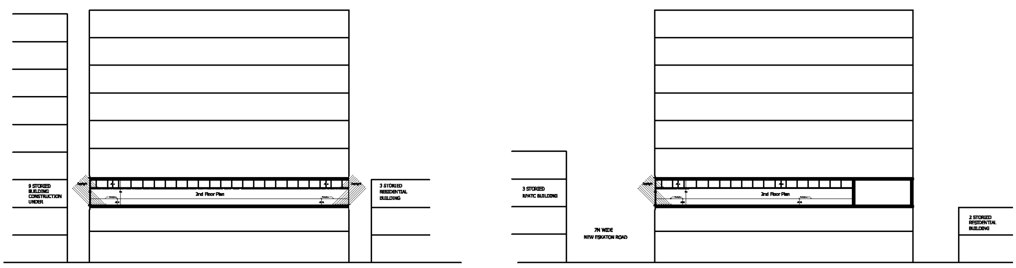


Figure 3: Conceptual building section thru XX' & YY' axis

The findings of the computer simulation were evaluated based on following criteria.

a) Average daylight level on the work-plane height.
b) Number of points within acceptable illumination levels.
c) Fluctuation of daylight levels from the window towards deeper spaces.
d) Comparison of rendered images of the example space generated by Radiance for luminance levels on the specified surface.
e) Different performance metrics with DAYSIM to verify the annual performance data.

9 Simulation Parameters

The quantitative and qualitative assessments for the daylight simulation were based on the following parameters:

Location	Dhaka, Bangladesh.
Longitude	90.2 deg
Latitude	23.5 deg
Local Terrain	Urban
Time	12.30 pm
Date	15, April (April is the hottest month, displaying the highest average temperature, during which the sky varies between conditions that are both clear as well as overcast, as found in the climatic study for Dhaka)
Calculation Settings	Full Daylight Analysis
Precision	High
Window (dirt on glass)	Average
Sky Illumination Model	CIE Overcast
Design Sky Illuminance	16,500 Lux (Khan 2005)

The second floor of the building was chosen for the simulation study, as it is largely an open plan area and being one of the typical floors, the plan is repeated on the rest of the six upper floors (Figure 4). The following are the parameters of the Model (incorporated from values found in a physical survey).

2nd floor dimensions	25m x 28.5m
Total floor area	692 sqm
Usable office space	577 sqm
Service area	115 sqm
Clear height of office space	3m (without false ceilings) 2.25m (with metal false ceilings)
Window to floor ratio	0.36
Work Plane height	0.75 m above floor level

The following parameters of existing internal finish materials (as found in the field survey) were used in the model for simulations.

Ceiling/ Roof of 2nd floor	White painted plaster (reflectance: 0.7)
Internal wall	White painted brickwork (reflectance: 0.7)
Floor	Reddish ceramic tiles finishes (reflectance: 0.6)
Glazing	Single pane of glass with aluminium frame (reflectance: 0.92, U value: 6W/m2K)

The upper and lower floors of the study space were hided during simulation, as it was found during trial simulation that these floors had no contribution to simulation output but prolong the simulation processing time unnecessarily (Figure 4).

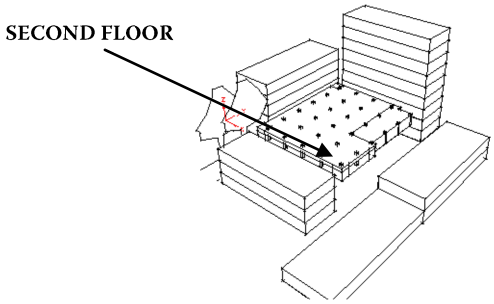


Figure 4: View of model used for the simulation.

10 Simulation study: comparing two models of the same space; isolated and with surroundings

For the first study, the second floor of the building was chosen to analyse the impact of surroundings on interior daylight distribution. This floor has different exterior conditions on its four different sides. The building has a 7m wide road on the west, some single-storey semi-pucca structures and a two storey building opposite the lift core on the east; another nine-storey building is under construction 2.5 m from the northern edge, while there is a three-storey building 2.5m on the south side. There is a four storey building and some greenery just opposite the road in front of the office building (Figure 5).

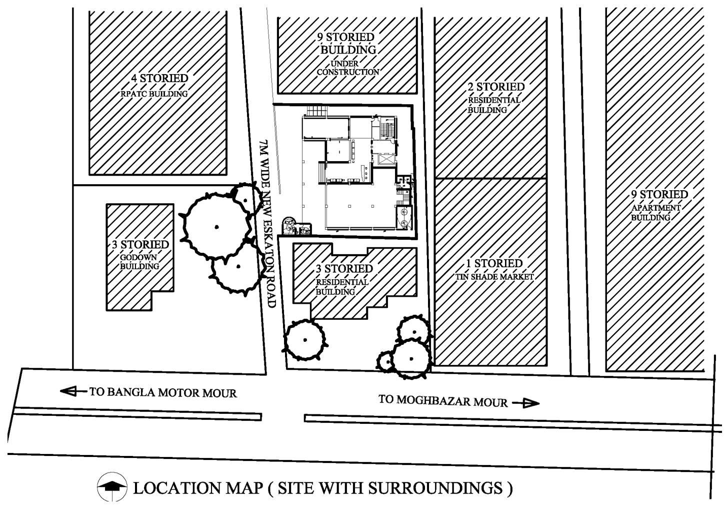


Figure 5: Site and surroundings of nine-storied Opsonin Building

During the study, the two situations (with and without obstructions) were compared. All indoor and outdoor conditions were kept constant in accordance with values measured during the physical survey. The initial model assumed a vacant interior space devoid of any partitions or furniture, and having no interior blinds, in order to avoid the effects of internal surfaces or elements which both block and/or reflect daylight.

10.1 Simulation findings

In Table 1, the values of daylight level on 83 visible nodes of the grid show an average of 296 lux, when simulated in the actual built-up setting.

Table 1: Daylight distribution on node points with actual built-up setting (see Appendix A)

	A	B	C	D	E	F	G	H	I
1	-	***409***	***358***	***412***	***334***	***396***	206	-	-
2	*1058*	103	64	74	63	55	32	-	-
3	*1137*	66	41	26	22	24	14	-	-
4	*1083*	100	40	21	12	10	9	-	-
5	*1188*	66	32	13	13	7	9	-	-
6	*1156*	105	33	25	14	6	8	-	-
7	*1172*	68	29	23	14	20	8	-	-
8	*1156*	133	40	26	20	39	54	124	***882***
9	*1130*	77	38	32	26	43	16	183	0
10	*1068*	126	71	72	70	95	108	234	*1352*
11	-	*1125*	*1063*	*1110*	***899***	*1143*	***649***	*1157*	0
Contour Range: 0-1400 Lux, Visible Nodes: 83, Average Value: 296 Lux									

In Table 2 the values of daylight level on 83 visible nodes of the grid show an average of 505 lux, when simulated as an isolated structure, without the presence of the built surroundings.

Table 2: Daylight distribution on node points with absence of the built surroundings (see Appendix B).

	A	B	C	D	E	F	G	H	I
1	-	*1576*	*1393*	*1629*	*1338*	*1610*	***850***	-	-
2	*1307*	***368***	265	***303***	261	225	132	-	-
3	*1372*	225	154	103	90	99	60	-	-
4	*1317*	274	133	87	50	39	37	-	-
5	*1433*	187	107	53	54	31	40	-	-
6	*1344*	257	104	78	42	26	35	-	-
7	*1387*	202	98	65	59	46	35	-	-
8	*1357*	290	125	81	59	90	91	145	*902*
9	*1374*	214	135	111	94	111	66	240	0
10	*1318*	***394***	263	262	245	***301***	263	***385***	*1421*
11	-	*1616*	*1554*	*1646*	*1361*	*1667*	*1052*	*1666*	0
Contour Range: 0-1700 Lux, Visible Nodes: 83, Average Value: 505 Lux									

10.2 Comparison

Comparing the above two conditions, it is found that the average daylight level for the unobstructed condition was 70.6% higher than the actual situation, clearly showing the significance of the surroundings. With building surroundings, the average value of incident daylight on work plane height is 296 Lux, only 23 points among 83 have values higher than 300 lux, which is the recommended level mentioned in Bangladesh National Building Code (BNBC 1993) for office work. If the deeper parts of the office interior are supplied with the recommended illumination level by supplementary light, then 15 peripherals points among 23 points will create glare, as these levels exceed three times the recommended values (Littlefare 1996; Goulding et al. 1992) leaving only 8 points within the range of acceptable daylight illumination level (300-900 Lux).

When the building surroundings were removed, the number of points receiving more than 300 Lux increased to 29 points, though only six among them were found to be within the acceptable range (300-900 lux). Another comparison shows the drop of light along XX' and YY' axis (Figures 6 & 7), which demonstrates that drop in illumination level is much sharper with distance from window when there are no building surroundings. The graphs also show that along the XX' axis the difference between the two situations is less significant as the actual building has more open spaces in east and west sides (along the XX' axis). Along the YY' axis, the differences between the two situations are significant near the window, especially to the north, due to the presence of a nine-storied building (Figures 3, 4 & 5).

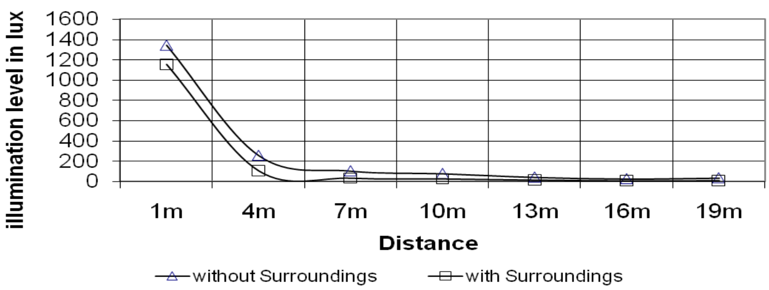


Figure 6: Drop of light along XX' axis with absence and presence of the built surroundings

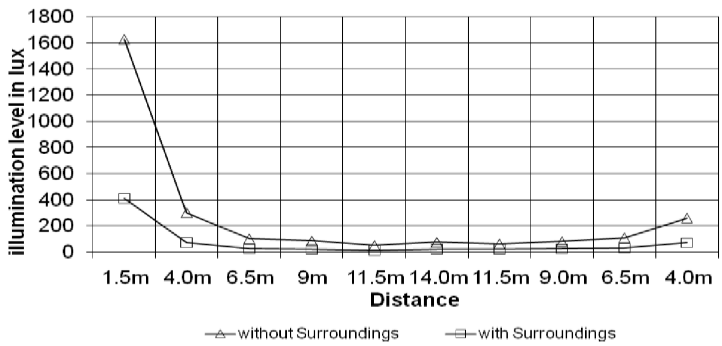


Figure 7: Drop of light along YY' axis with absence and presence of the built surroundings

11 Internal Venetian Blind

The facade is the interface used to control the internal daylight conditions of an office building. From the daylight perspective, the building envelope can be thought of as a light filter to control the quantity and quality of the lighting (Bell et al. 1995). During the physical survey it was identified that internal blinds have a significant impact on incident daylight and with a glazed window it acts as a visual screen/barrier or filter between indoor and building surroundings.

Different types of venetian blinds are available to block or divert direct sunlight to reduce glare (A.G.S. 2000). Some blinds offer excellent glare control and can be motorized when used in large offices. Blinds can be incorporated within panes of glass to protect it from damage. Very sophisticated blinds with tilt of the blades can vary to enable the top of the blind to reflect light up to the ceiling of a room, whilst the lower blades control the sunlight by reflecting it away from the building. Advance blind can meet the individual requirements of the building by varied surface design of the horizontal slats.

The obvious advantage of the venetian blind is that it can, and should, be raised when not needed, for sun control; the problem is that once lowered it tends to be left in the closed position, especially in offices where personalised touches are limited. A procedure should be adopted to ensure that their use is optimized and a simple solution might be for the office cleaners to open the blinds to ensure that each day starts with them open to admit the maximum daylight.

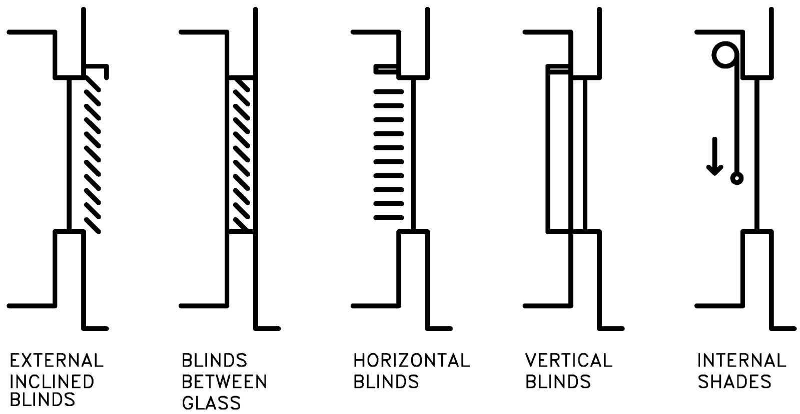
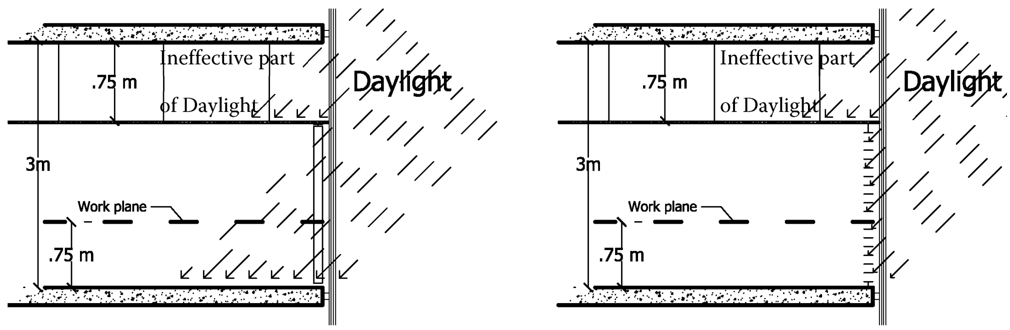


Figure 8: Different shading devices near glazing surfaces. (Source: A. G. S. 2000)

Other types of blinds are also available, the vertical hung louver blind where the louver slats can be rotated, or moved to one side, to offer flexibility, provide privacy, and together with roller blinds and those of other materials, can provide low-cost solutions in the domestic situation (Figure 8). The next section reports on a simulation done to evaluate the configuration of internal blinds (vertical and horizontal) most popular and available in Dhaka city (Joarder 2007), aiming to maximise the quality of daylight at work plane height, considering the true building surroundings described above. Simulation can most effectively be used to take decisions regarding this sort of detailing during design, to increase sustainability.

12 Second simulation study: configuration of internal blinds

To make the decision about the configuration of internal blinds to maximise the quality of daylight at work plane height considering the true building surroundings, daylight simulation was done for two different types of internal blinds, made of fabric (vertical & horizontal) covering the same window area of 208 sqm of the examined floor. Two alternative models of the same space were created for two different internal blinds, the first consisting of vertical blinds of 2250mm x 100mm strips (Figure 9a) 100mm apart, the second of edge to edge long 100mm wide horizontal strips placed 100mm apart (Figure 9b). Other parameters and procedures were the same as those of previous section.



a) Vertical blinds *b) Horizontal blinds*

Figure 9: Section shows daylight penetration for two types of internal blinds

12.1 Simulation findings:

In Table 3 the values of daylight level on 83 visible nodes of the grid show an average of 167 lux with the vertical blinds. In Figure 10a the output of Radiance Synthetic Imaging software shows the daylight contour distribution of the space.

Table 3: Daylight distribution on node points with 100mm vertical blinds (see Appendix C)

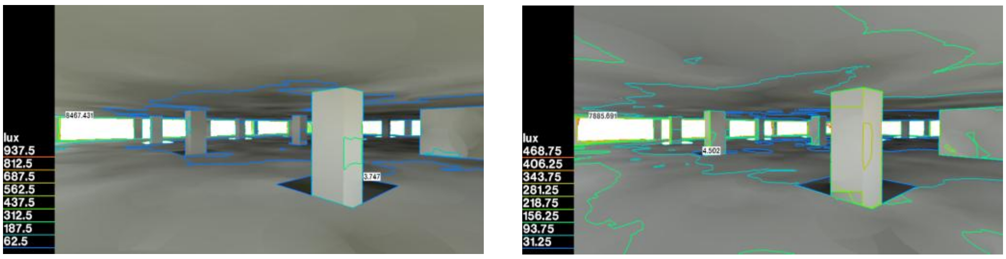
	A	B	C	D	E	F	G	H	I
1	-	196	201	209	174	224	98	-	-
2	***634***	79	33	53	44	40	22	-	-
3	***597***	46	25	17	19	19	9	-	-
4	***474***	81	21	16	9	7	6	-	-
5	***684***	29	18	10	9	6	6	-	-
6	***682***	76	27	22	8	5	5	-	-
7	***689***	34	22	14	12	16	4	-	-
8	***620***	101	27	18	15	28	37	85	***568***
9	***599***	46	25	20	15	39	10	117	0

10	***691***	92	50	44	37	58	71	175	**773**
11	-	***537***	***650***	***555***	***620***	***450***	***338***	***635***	0
Contour Range: 0-800 Lux, Visible Nodes: 83, Average Value: 167 Lux									

Table 4 gives the values of daylight level on these same visible nodes of the grid with horizontal blinds. The average is considerably lower than the previous one, being only 97 lux. In Figure 10b the output of Radiance Synthetic Imaging software shows the daylight contour distribution of the same space with these horizontal blinds.

Table 4: Daylight distribution on node points with 100mm horizontal blinds (see Appendix D).

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
1	-	98	130	133	117	119	62	-	-
2	***300***	90	50	50	47	52	29	-	-
3	***391***	52	32	22	22	18	12	-	-
4	***305***	66	37	18	12	9	8	-	-
5	***331***	41	29	11	12	6	9	-	-
6	***326***	71	30	23	14	6	7	-	-
7	266	54	20	23	14	20	8	-	-
8	272	119	35	24	18	36	49	97	272
9	240	73	36	30	18	40	13	141	0
10	***322***	111	59	60	53	74	93	218	**522**
11	-	243	191	214	205	194	85	256	0
Contour Range: 0-500 Lux, Visible Nodes: 83, Average Value: 97 Lux									



(a) With 100mm vertical blinds *(b) With 100mm horizontal blinds*

Figure 10: Daylight contour distributions with internal blinds. (Software: Radiance)

12.2 Comparison

Comparing the above two conditions, it is found that the average daylight level above work plane is 72% higher for the 100mm internal vertical blinds compared to edge to edge long strip horizontal blinds of the same width. For horizontal blinds among the 83 points only 7 points have values higher than the BNBC (1993) recommended level of 300 lux. The number of points receiving more than 300 lux increased to 18 points with the vertical blinds, and all of them are within acceptable range. However, comparison of the drop of light along XX' and YY' axis in Figure 11 & Figure 12, demonstrates that the drop is much sharper yielding poorer distribution of light, with vertical blinds than with horizontal ones. This is also demonstrated in the three-dimensional qualitative comparison with daylight contour distribution on work plane height generated from Radiance output (Figure 10) which shows qualitative improvement in overall daylight level for the horizontal blinds with brighter reflected ceilings and work-plane.

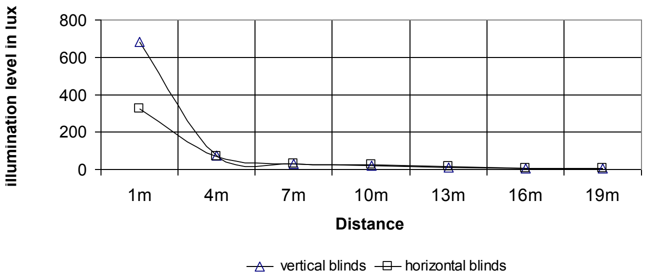


Figure 11: Drop of light along XX' axis with two different types of internal blinds.

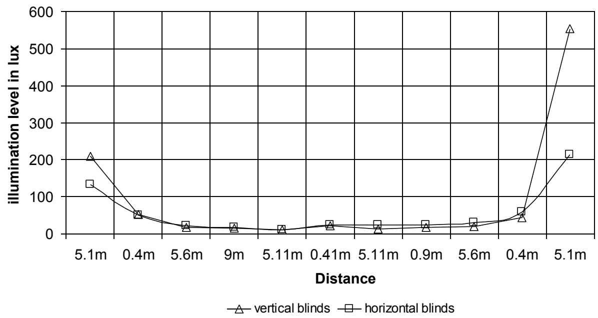


Figure 12: Drop of light along YY' axis with two different types of internal blinds.

12.3 Decision based on simulation findings

The comparisons of daylight levels on the intersection grid points for the two conditions show that although both the configurations of internal blinds cover the same window area (208 sqm), the vertical blinds of 2250mm x 100mm size allow higher average daylight penetration. However, the Radiance output shows that horizontal blinds perform better when considering overall daylight distribution in the space. This reflects the understanding that up to a limit, reducing contrast in any space, improves its visual character.

Daylighting design is both an art and a science (I.E.A. 2000). Qualitative information and visual feedback on daylight designing are usually as important for the building designer as the quantitative figures that reflect the engineering aspect of daylighting design.

From the output of the two different programs (Ecotect & Radiance) two different configurations of internal blinds are suggested. Comparing the peripheral illumination (column A, row 1 & 11 of Table 3 & 4) of the study space for two different blind configurations, it is evident that the qualitative increase of average illumination values for vertical blinds are due to the higher illumination near windows. Proper daylight design should reduce illumination close to standard near windows and increase the illumination in deeper spaces to ensure a uniform distribution of daylight over the space. So, from qualitative judgement the performance of horizontal blinds are better. On the other hand, Radiance is considered one of the most powerful daylight and electrical lighting analysis tools available (Baker et al. 2002; Mistrick 2000) and the image generated by Radiance is capable of giving qualitative information so, the findings of Radiance can be considered more appropriate to come to a decision about the preferred configuration of internal blinds.

Although overcast sky presents the more critical condition, it is also important to get a complete picture about the performance of the studied blind configurations in other types of sky conditions (clear sky, intermediate sky etc.) apparent in different period of the year. So, finally a simulation was run with DAYSIM to verify the annual performance of the two blind configurations. Table 5 summarizes the non- default Radiance simulation parameters.

Table 5: Utilized Simulation Parameters in DAYSIM.

Ambient bounces	**Ambient division**	**Ambient sampling**	**Ambient accuracy**	**Ambient resolution**	**Specular threshold**	**Direct sampling**
5	1000	20	.01	300	0.15	0.2

For two types of blind configurations, daylight factor (DF), conventional daylight autonomy (DA), continuous daylight autonomy (DAcon), and useful daylight index (UDI) were calculated. For all performance metrics, the same annual illuminance profiles were used based on DAYSIM calculations. The simulation time step was one hour. Results for the different performance metrics are shown in Table 6.

Table 6: DAYSIM simulation results for two types of internal blinds.

Variant	**Vertical blinds**	**Horizontal blinds**
Point illumination that have a Daylight Factor (DF) of 2% or higher.	49%	51 %
Daylight Autonomy (DA)	0% - 100%	0% - 100%
Continuous Daylight Autonomy (DAcon) > 80%	86 %	86 %
Maximum Daylight Autonomy (DAmax) > 5%	34 %	36 %
Useful Daylight Index (UDI) <100	100 %	100 %
Useful Daylight Index (UDI) 100–2000	0 %	0 %
Useful Daylight Index (UDI) >2000	0 %	0 %

Comparing the annual performance metrics for two conditions, it is found that the continuous daylight autonomy above 80% and useful daylight index (UDI) are same for two configurations. But, point illumination that have a daylight factor of 2% or higher above work plane is 2% higher for horizontal blinds compared to vertical one. 36% of all illuminance points have a maximum daylight autonomy above 5% for horizontal blinds compared to 34% for vertical blinds. Therefore, based on the annual performance metrics of two configurations from DAYSIM, horizontal blinds are ultimately suggested for a better overall visual environment.

13 Conclusion

Most of nature is disappearing due to urbanisation. Daylight is, albeit only in scarce amounts, often the sole remnant of nature – and it can only be enhanced with a closer coupling of the interior with the outside. These are questions, which are going to become increasingly relevant as urbanisation continues and the pressure to build bigger and deeper buildings grows.

In this paper, aiming for sustainable office spaces, trials have been done to highlight the procedure of perceiving the actual condition of daylight distribution in an urban office interior using computer generated simulation programs. It has been found from comparative simulation studies of a selected building with and without surrounds, that surroundings significantly influence daylight penetration indoors. In fact the comparison in the selected building shows that increased glazing on north provides little positive gain in daylight distribution, despite established knowledge regarding advantages of this orientation. This is a direct result of the effect of the high-rise construction just beside the north boundary which acts as obstruction to daylight penetration. Similarly, contrary to expectations, the west facade of the building is the most potential surface for lower floors from daylighting strategy due to the wide access road on this orientation, which acts as an open space adjacent to the building.

These results demonstrate that while designing in an urban site theoretical and common sense knowledge about building orientation and the historical climatic reference of the geographical region is largely ineffective and is subordinate to the site situation. Designers in such situations have to pay great attention to the surroundings.

Simulation can predict the actual impact of the building surroundings, and can be used before finalizing the building design and starting construction. This paper demonstrates the decision-making process regarding one of the design details, i.e. blind configuration, using simulation by comparing results of the configuration and choosing the more desirable option. The urban situation investigated here is a typical one, but for differing situations, the same process can be applied for decision-making. Similarly the simulation process can also be used for deciding other design details. To validate the simulation results, measurements of daylight levels were taken by a light meter (TES 1332 Digital Lux Meter) on the study space, to compare illumination values generated by the Ecotect with the actual daylight levels on April 15, 2007 at 12.30 pm (date and time used in simulation) when the sky was overcast. The deviation between actual and simulated lighting levels was 5 % (15 lux on average) approximately (Joarder, 2007).

It is the task of the Architect to design using sustainable options for buildings, and analysis aiming towards sustainability can be strengthened by use of simulation programs. The discussion in this paper is limited to the impact of surroundings on daylight penetration. However, the building surroundings also influence heat flow and radiation protection, ventilation, acoustics and other subjective concerns like that of privacy and view. All these affect the environment and thus have energy implications, i.e. active energy (electricity) consumption may be required to rectify these adverse effects. Such aspects require to be studied with care in order to create sustainable building solutions which take into account the total energy regime of the built-form. Simulation is a viable option to study each of these separately and in combination with each other.

Acknowledgements

We would like to thank all of the people who helped make this investigation possible, in particular: Managing Director, Opsonin Pharma Limited, for extending his kind consent on conducting survey on their building with providing all relevant information about the building to generate example space for simulation study, and Dept. of Architecture, Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh for technical support.

References

A.G.S. (2000) “Architectural Graphic Standards”, John Wiley & Sons, Inc. New York, CD Rom Versions.

Ahmed, Z N (1997) Daylighting in Buildings in combination with Artificial Lighting Systems, Multi-topic Symposium '97, organised by the Institution of Electrical and Electronics Engineers, Pakistan (IEEEP), 5-6 March 1997, Karachi, Pakistan.

Ahmed, Z N, Joarder, M A R (2007) An Observation on Daylight Inclusion in the Lighting of offices in Dhaka, ‘Protibesh’ (Journal of the Dept. of Architecture), volume 11, issue 1, 51-61.

Baker, N (2008) “We are all outdoor animals”, Velux A/S, http://www.thedaylightsite.com/showarticle.asp?id=38&tp=6, accessed on,15 December 2008.

Baker, N and Steemers, K (2002) “Daylight Design of Buildings”, James & James Ltd.,William Road, London.

Baker, N, Steemers, K (2002) “Daylight Design of Buildings”, James & James Ltd.,William Road,London.

Begemann, S. H. A., van den Beld, G. J., and Tenner, A. D. (1997). Daylight, artificial light and people in an office environment: Overview of visual and biological responses. International Journal of Industrial Ergonomics. 20(3). pp.231–239.

Bell, J, Burt, W (1995) “Designing buildings for daylight”, Construction Research, Communications Ltd, BRE: London.

BNBC (1993) “Bangladesh National Building Codes”, Housing and Building Research Institute and Bangladesh Standards and Testing Institute, City Art press Ltd, Dhaka.

Clanton and Nancy, presentation, (2004). Design for Health: Summit for Massachusetts Health Care Decision Makers, 28 September.

Crawley, D B, Hand, J W, Kummert, M and Griffith, B T (2005) Contrasting the Capabilities of Building Energy Performance Simulation Programs Joint Report Version 1.0. Proceedings of the International Building Performance Simulation Association 2005 Montreal, August 15 – 18.

Flint, F O (1984) Advances in light microscopy of foods. In: G.G. Birch and K.J. Parker, (eds.) “Control of food quality and food analysis”. London: Elsevier Applied Science Publishers.

Fontoynont, M, Tsangrassoulis, A, Synnefa, A (2004) SynthLight Handbook Chapter 2: Daylighting, The research was part-funded by the European Commission under the SAVE programme, Revision: 22 April 2004.

Goulding, J R, Lewis, J O, Steemers, T C, (eds) (1992) “Energy Conscious Design: A Primer for Architects”, London, Batsford for the European Commission.

International Energy Agency I.E.A. (2000) “Daylight in Buildings, a source book on daylighting systems and components”, A report of IEA Solar Heating and Cooling Task 21/ Energy Conservation in Buildings and Community Systems Programme, Annex 29, July 2000.

Joarder, A, Price, A and Mourshed, M (2009). A Systematic Study of the Therapeutic Impact of Daylight Associated with Clinical Recovery, proceedings of the HaCIRIC PhD workshop, 2nd Annual International Conference of the Health and Care Infrastructure Research and Innovation Centre, Improving healthcare infrastructures through innovation, 1-3 April, Brighton, UK. pp. 25-31.

Joarder, M A R (2007) “A Study of Daylight Inclusion in Luminous Environment of Offices in Dhaka City”, Unpublished M. Arch Thesis, Department of Architecture, BUET, Dhaka.

Khan, M N Z I (2005) “Rethinking Learning Spaces: in warm-humid climatic context with special reference to Dhaka, Bangladesh”, Unpublished MA Dissertation , Environment and Energy Studies Programme, Architectural Association Graduate School, London.

Koenigsberger, O H, Iingersoll, T G, Mayhew, A, Szokolay, S V (1997) “Manual of Tropical Housing and Building”, Climatic Design, Orient Longman Ltd, Chennai.

Littlefair, P J (2001) Daylight, Sunlight and Solar Gain in the Urban Environment, “Solar Energy”, volume 70, no. 3, 177–185.

Littlefare, P J (1996) “Designing With Innovative Daylighting”, Building Research Establishment report, Construction research Communications Ltd, Herts, UK.

Loftness, V ,Hartkopf, V ,Khee, L ,Snyder, M , Hua, Y , Gu, Y , Choi, J and Yang, X (2006) Sustainability and Health are Integral Goals for the Built Environment. Healthy Buildings, June 4-8. Lisbon, Portugal.

Mistrick, R G (2000) “Desktop Radiance Overview”, Pacific Gas & Electric, The Pennsylvania State University, Pennsylvania.

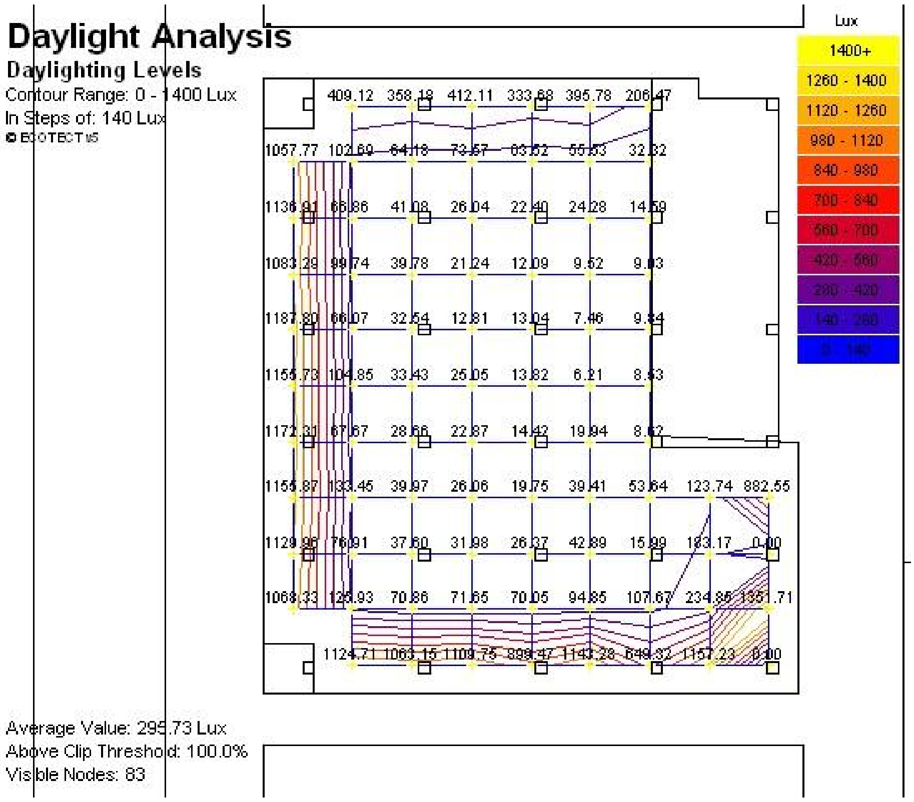
Osaji, E E and Price A D F (2009) The Role of Parametric Modelling and Environmental Simulation in Stimulating Innovation in Healthcare Building Design and Performance, HaCIRIC 2nd International Conference, April, pp. 135-44.

Phillips, D (2004) “Daylighting: Natural Light in Architecture”, Architectural Press, Wheeler Road, Burlington.

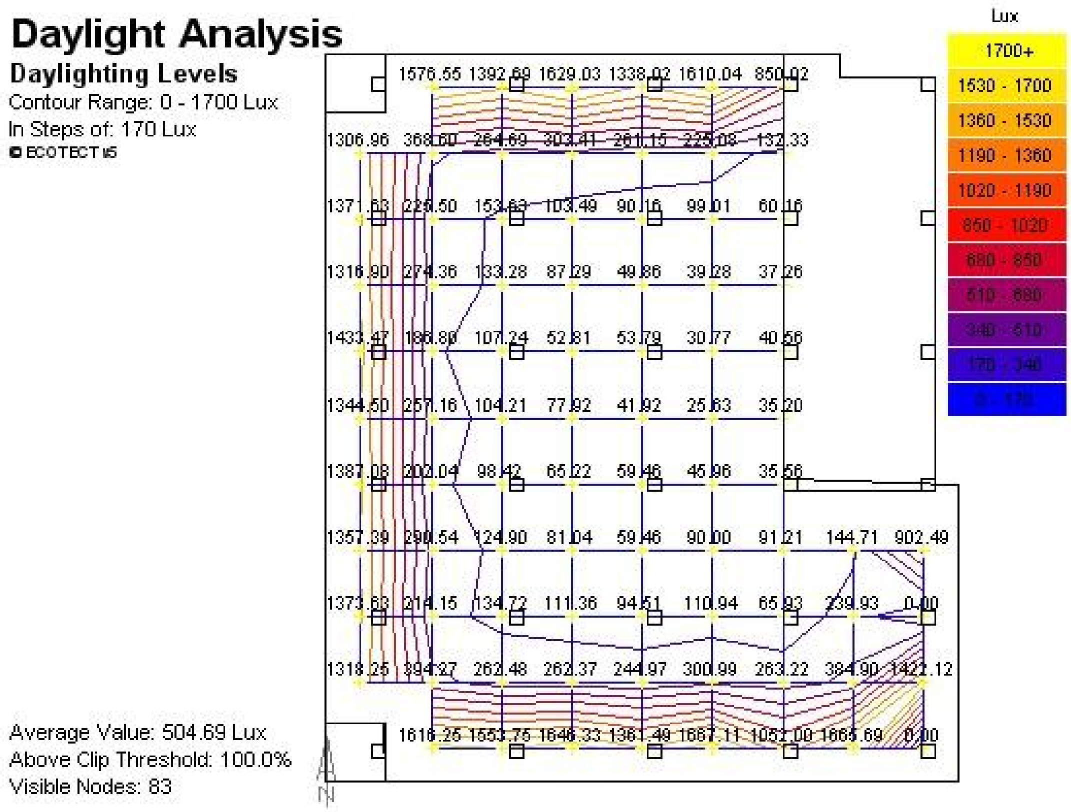
Sustainable development International Corporation. SDIC (2008). Greening your Workplace: The Healthy Office and Productivity. http://www.smartoffice.com/healthyoffice.html, accessed on, 15 December 2008.

Appendices

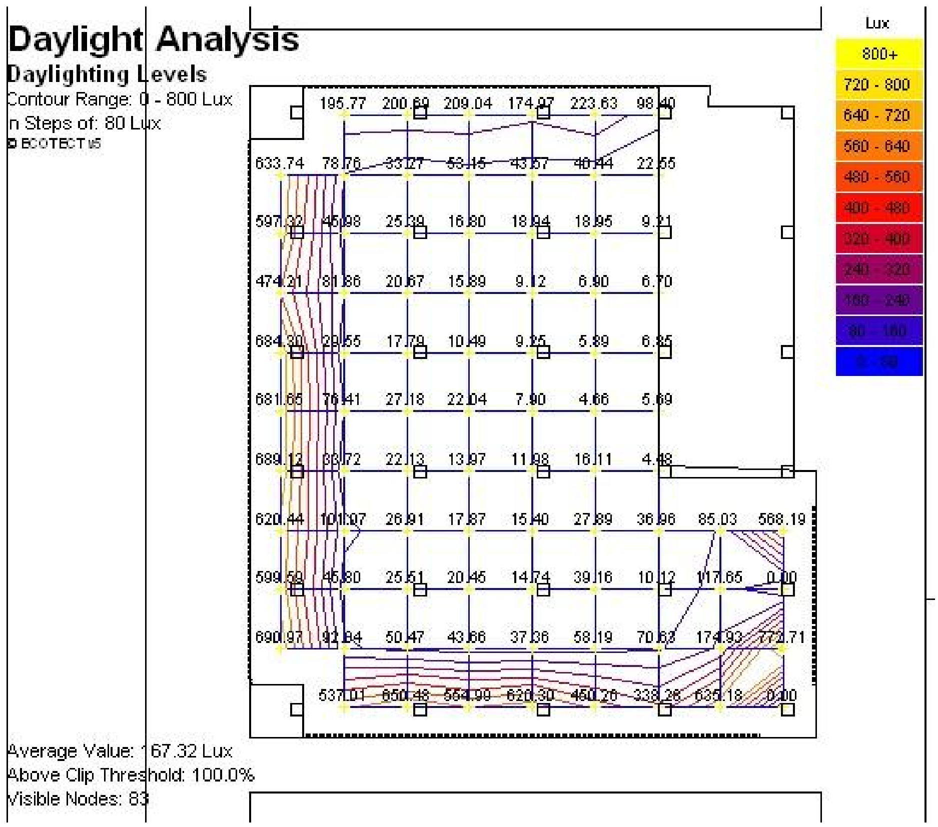
Appendix A: Daylight distribution on node points with actual built-up setting. (Software: Ecotect findings)



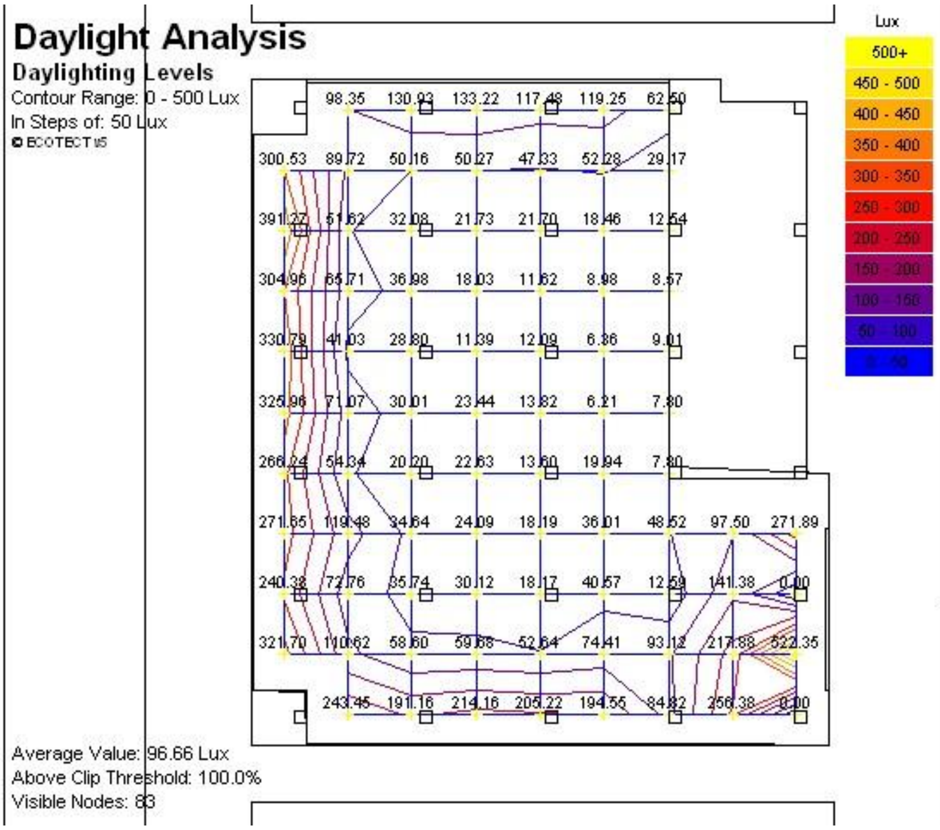
Appendix B: Daylight distribution on node points with absence of the built surroundings. (Software: Ecotect findings)



Appendix C: Daylight distribution on node points with 100mm vertical blinds. (Software: Ecotect findings)



Appendix D: Daylight distribution on node points with 100mm horizontal blinds. (Software: Ecotect findings)


Daylight Analysis
Daylighting Levels
Contour Range: 0 - 500 Lux
In Steps of: 50 Lux
© ECOTECT v5
Lux
500+
450 - 500
400 - 450
350 - 400
300 - 350
250 - 300
200 - 250
150 - 200
100 - 150
50 - 100
0 - 50
98.35 130.93 133.22 117.48 119.25 62.50
300.53 89.72 50.16 50.27 47.33 52.28 29.17
391.27 51.62 32.08 21.73 21.70 18.46 12.54
304.96 65.71 36.98 18.03 11.62 8.98 8.57
330.79 41.03 28.80 11.39 12.09 6.36 9.01
325.96 71.07 30.01 23.44 13.82 6.21 7.80
266.24 54.34 20.20 22.63 13.60 19.94 7.80
271.65 119.48 34.64 24.09 18.19 36.01 48.52 97.50 271.89
240.38 72.76 35.74 30.12 18.17 40.57 12.59 141.38 0.00
321.70 110.62 58.60 59.68 52.64 74.41 93.12 217.88 522.35
243.45 191.16 214.16 205.22 194.55 84.82 256.38 0.00
Average Value: 96.66 Lux
Above Clip Threshold: 100.0%
Visible Nodes: 83

Adamstown: a sustainable new town for Co. Dublin, Ireland?

Dr Dexter Hunt[1], I Jefferson[1], C D F Rogers[1], D Butler[2], F A Memon[2]

1 – University of Birmingham, UK

2 – University of Exeter, UK

A new 223 ha town is being developed on the south side of Lucan, 10 miles west of Dublin's city centre in the Republic of Ireland (RoI), via an ambitious twenty-year development. 'Adamstown', as it is named, is the first Strategic Development Zone (SDZ) in ROI and when completed it will consist of: 32 ha of open space (including 4 major parks); a 8.3 ha acre town centre named Adamstown Central (with an 8 screen cinema, restaurants, cafes and bars); 10,150 residential units (some with underground parking); 125,500m^2 of retail outlets and offices; 3 primary schools; 1 post-primary school; a library; a railway station; and a fire station. The population of this new town is expected to grow to more than 30,000 by 2015. This €4 billion project is well underway and is currently reported to be setting new benchmarks for European town planning.

This paper describes the Adamstown development and discusses the attempts being made to consider sustainability (not least for transport, energy and water services) within its overall infrastructure plan. The paper discusses the legacy being left for future residents of Adamstown considered in the context of future scenarios for the town.

Keywords: community planning, community sustainability, infrastructural development, sustainability assessment, sustainable development, urban infrastructure

1. INTRODUCTION

Between 1996 and 2016 a new town, the first to be built in the Republic of Ireland (RoI) for more than twenty years, is being developed on a 223 ha site to the south-west of Lucan (10 miles from Dublin's City centre) just off the N4 and in close proximity to the main M50 motorway. When completed the population of this new town is expected to grow to more than 30,000 making it as large as neighboring towns of Drogheda and Dundalk. Moreover it will increase the population of the greater Lucan area to more than 50,000 - census figures already show Lucan to be the fastest growing town in RoI (CSO, 2006). An underlying aim of the development is to create a sustainable and vibrant community and this appears to have been fully embedded within the decision-making process from an early stage. This is very interesting given that in 1996, as ideas for Adamstown were being conceived, Sustainable Development (SD) principles formed an as yet unclearly defined cornerstone of Government Policy (Mahoney, 2007). It is true that such a shortfall in knowledge did exist; however, this was the beginning of vitally important changes within the Irish planning system with regard to SD. Interestingly these changes mirror those occurring in the UK in the same time period (see for example Porter and Hunt, 2006) and included the development of clear strategies and guidelines for SD (e.g. *Sustainable Development - A Strategy for Ireland,* DoE, 1997, *The Strategic Planning Guidelines for the Greater Dublin Area*, Martin et al, 1999). In addition Acts of Parliament that included the SD agenda were being implemented (e.g. *The Planning and Development Act 2000,* Acts of the Oireachtais, 2000). Both of these sets of activities attested to SD being integrated within the heart of the planning system in RoI. During this time the sustainability concept within Adamstown was barely a skeleton, more of a series of aspirations, although even at the early stages of development (i.e. visioning) one of key aspirations for Adamstown was very clear - to be a 'sustainable community' centered on the railway station rather than an agglomerate of housing estates bolted onto the edge of Lucan (Mahoney, 2007). Moreover this vision was endorsed by the all members of the team.

The *Adamstown Local Area Plan* (LAP, 2001) identified many details of the Adamstown development, including: the nature and extent of buildings and the uses that could be permitted therein; the amenities and facilities required; and the services and infrastructure necessary to serve the now 'zoned' Adamstown lands (Johnson, 2001). The LAP aimed to "create a sustainable and vibrant community based on a traditional town format with a wide range and choice of dwellings, shopping services, employment, education and leisure facilities and amenities", moreover it was where sustainability became fully integrated into the project (Mahoney, 2007). Since this time and following on from key publications such as *Making Ireland's Development Sustainable* (a review of progress since Rio, DoELG, 2002) there has been huge impetus towards creating sustainable communities - not least in urban areas. Therefore it is not surprising that the aim of achieving a sustainable community was fully endorsed within the *Adamstown SDZ Planning Scheme* when it was published in 2003 (SDCCPD, 2003).

More recently Draft Planning Guidelines (DPG) and Manuals have outlined salient features for achieving sustainable urban residential development, set within the context of RoI. These have included *Sustainable Residential Development in Urban Areas* (EHLG, 2008a), the draft of which was published in February 2008, and *The Urban Design Manual* (a companion document to the DPG published in March 2008, EHLG, 2008b). Adamstown has been at the forefront of such design initiatives, being cited as a sustainable exemplar in both of these documents. Within planning circles Adamstown is already reported to be setting new benchmarks for European town planning and it is not surprising therefore that many prizes have already been won, including: the Irish Planning Institute's Principal Award in 2005; Irish Residential Development of the Year in 2007; and first place in two categories (Best Private Housing Development and Best Affordable Housing Development) for the Local Authority Members Association (LAMA) in 2008. Therefore the benefit of having an early shared vision for the creation of a sustainable community is already paying dividends. In addition the establishment of Adamstown as a Strategic Development Zone (SDZ) has undoubtedly played a significant role in its swift delivery. Adamstown, being the first SDZ in RoI, is undoubtedly setting the standards for future town development using such an approach.

Section 2 of this paper discusses further the role of an SDZ and briefly introduces the Adamstown development. Further details of the development are given in Section 3 from where the paper examines more closely the steps being made to deliver a new sustainable town for Co. Dublin, RoI. This examination uses the 'lens' of infrastructure provision (i.e. community, transport, energy, water, information technology and waste) and includes examination of the use of space, i.e. that which exists above and below ground. Throughout the paper many parallels and differences are highlighted with regard to policy requirements (and aspects of everyday living) within Adamstown (RoI) and the UK; illustrating the differences between two neighboring EU countries emphasizes the necessity of considering local priorities when considering sustainability (a core finding of current UK research, see www.esr.bham.ac.uk). Section 4 provides a discussion on the lessons being learned from the Adamstown development and summarises both the opportunities being seized and those being missed. Moreover it provides an insight into the legacy being left for future residents - considered in the context of possible future scenarios for the town.

Future scenarios research using international case studies forms part of the research work being undertaken currently by the Urban Futures project team, a joint research collaboration between the Universities of Birmingham, Exeter and Lancaster, and Birmingham City University. (Further details are provided at www.urban-futures.org).

2. THE ADAMSTOWN STRATEGIC DEVELOPMENT ZONE (SDZ)

Adamstown is the first Strategic Development Zone (SDZ) to be built since the RoI government introduced the concept in Part IX of the *Planning and Development Act* in 2000 (Irish Statute Book, 2000). An SDZ is distinct from normal developments in several ways, including: the fact that it supersedes any contrary provisions of the development plan; there are no appeal opportunities to An Bord Pleanala (the Irish Planning Board); and the planning authority can use any available powers (including CPO procedures) in order to secure or facilitate provision of the SDZ. The reasoning behind an SDZ is best captured by (EHLG, 2008a):

An SDZ provides an integrated planning framework and as such is highly suitable for creating sustainable neighbourhoods. They are designated by Government Order, where the site in question is deemed to be of strategic economic or social importance to the State. They have a *number of advantages in this regard, including the speedy delivery of residential development following approval of the planning scheme.*

On 19th June 2001 the Adamstown Strategic Development Zone (SDZ) was established by Statutory Instrument (S.I. No.272 of 2001), and was adopted on 1st July 2001 following the publication of the *Adamstown Local Area Plan* (Johnson, 2001). The specified Development Agency (akin to a Regional Development Agency in the UK) for Adamstown is South Dublin. The draft planning scheme was submitted in December 2002 and approved on 26th September 2003. The original proposal was for 1,035,000 m^2 (9,950 homes) of residential and 125,000 m^2 of non-residential development (for greater detail see SDCCPC, 2003).

As shown in Figure 1 Adamstown consists of 11 distinct named Development Areas and 4 Amenity Areas (consisting of 3 parks and 1 central boulevard). In most cases the names give individual identity to the various areas and may reflect the history therein (e.g. historically the area named Airlie stud was used as a stud farm). Table 1 shows the finer details of the Adamstown development, including: gross and net areas (varying from 8.3 ha to 21.7 ha); areas of open space allocated; the number of residential units and other types of development being built (residential units range from 1 bed apartments through to 5 bedroom luxury homes, Table 2); and their character, i.e. density (low being < 50 dwellings/ha, medium, and high being >75 dwellings/ha) and maximum building heights (these vary upward relative to density, i.e. 15, 21 and 30 m respectively). The details for the Adamstown development shown in Tables 1 and 2 include, where possible, any changes (up to December 2008) made to the development proposal since its first approval in 2003.

Specific aspects of the development relating to sustainability are discussed Section 3. The development is being carried out in 13 identified phases and these are summarised in Table 3. An important part of the phasing was for infrastructure provision to take place in tandem with residential occupation, this being in line with the requirements for an SDZ. This €4 billion landmark project is already well underway and at the time of writing this paper development had progressed to Phase 8. The €1.2 billion development of Adamstown Central (Development Area 11 in Table 1), one of the largest ever mixed use planning applications in the history of RoI (Tyrell, 2008), was granted permission to start on 18th July 2008 (Section 3.3). The latest application to be granted in Adamstown on 3rd November 2008 was for the initiation of a residential development (316 units) in the Tobermaclugg Village. The development is expected to be completed by 2016.

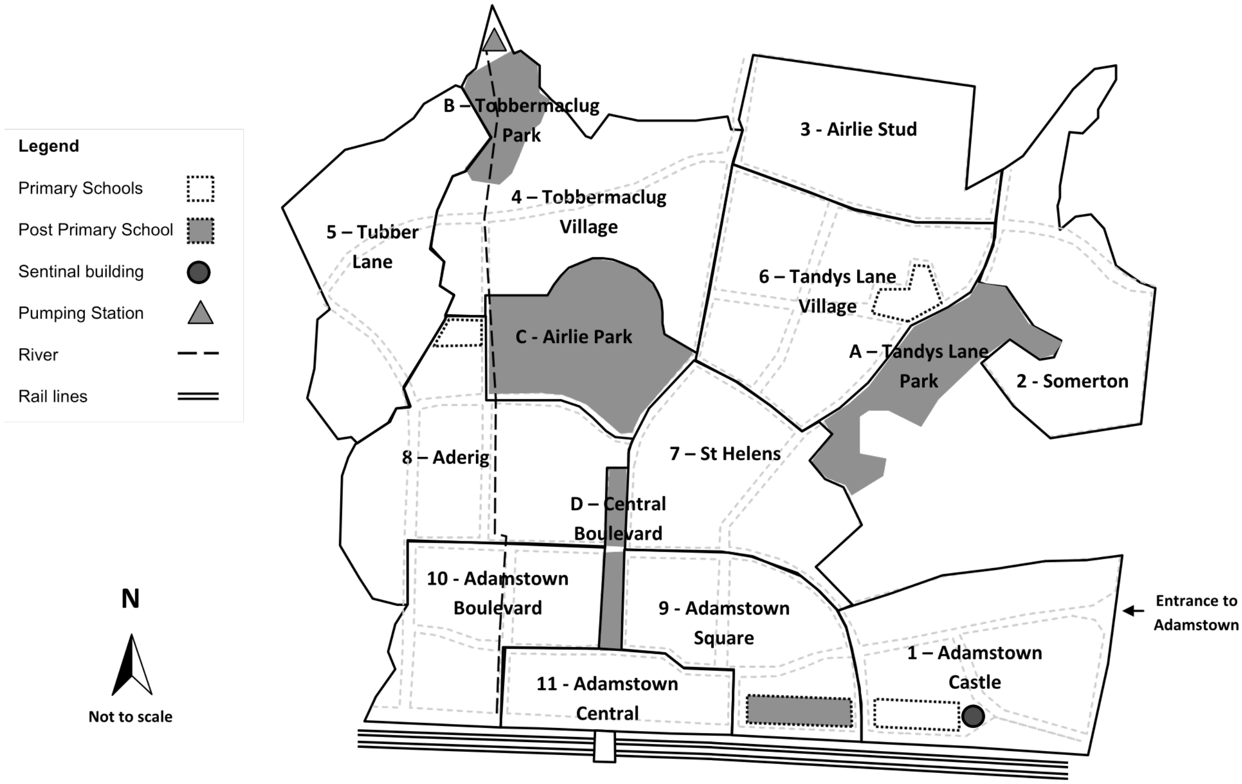


Figure 1 The Adamstown Development Plan (11 development areas and 4 amenity areas shown)

Table 1. Characteristics of the Adamstown development (adapted from SDCCPD, 2003 unless otherwise stated)

	Development Area (1-11) Amenity Area (A to D)	Area [net] (ha)	Open space (ha)	Residential units	Other type of development	Density range (dwellings/ha) [height max. (m)]
1	Adamstown Castle (2 stage)	21.1 [12.1]	0.76	623	P.Sch, O, Re	42-50 [15]
2	Somerton	14.5 [12.8]	0.52	650	FS, Re	35-42 [15]
3	Airlie Stud (Paddocks: 2 stage)	15.6 [14.5]	0.56	700	Re	40-48 [15]
4	Tobermaclugg Village	21.4 [19.3]	0.77	1050	Re	45-54 [15]
5	Tubber Lane	18.8 [17.6]	0.67	850	Re	40-48 [15]
6	Tandy's Lane Village	21.7 [17.0]	0.78	1025	P.Sch, Re	50-60 [21]
7	St. Helens	16.0 [14.2]	0.57	1100	Re,	65-78 [21]
8	Aderrig	21.7 [17.8]	0.78	1400	P.Sch, Re	65-78 [21]
9	Adamstown Square	15.1 [12.1]	0.54	1100	Re	75-90 [30]
10	Adamstown Boulevard	14.4 [11.3]	0.50	1025	PP.Sch, Re	75-90 [30]
11	Adamstown Central (2 stage)	8.3 [6.2]	0.30	606[1]	C, Re, O, L, HC	75-90 [30]
	Total	188.6 [166]	6.75	9956	-	**Character**
A	Tandy's Lane Park	8.0 [7.7]	-	-	-	Major
B	Tubermaclugg Park	3.8 [3.4]	-	-	-	Major
C	Airlie Park	11.6 [10.9]	-	-	-	Major
D	Central Boulevard	1.9 [1.3]	-	-	-	Urban
	Total	25.3 [23.3]	32.05	-	-	-

[1]SDCCPD (2008)

Key: Other type of development

C – Commercial
CC – Community Centre
P.Sch - Primary School
FS – Fire Station
HC – Health Centre
L – Leisure
O - Office
Re - Retail
PP.Sch – Post Primary School

Table 2. Residential unit sizes

	Type	**Apartments (m^2)**	**Houses (m^2)**
i	One bedroom	45	50
ii	Two bedroom	65	70
iii	Three bedroom	85	90
iv	Four bedroom	105	110
v	Five bedroom	120	125

Table 3 Phases of development (adapted from SDCCPD, 2003)

Phase	Dwellings	Actions being taken (date completed)
1A	0 - 500	• Upgrading of Newcastle Road • One side of Adamstown Link Road • Initial section of main Adamstown Station Road • Lucan / Palmerstown High Level Supply Scheme (2006) • Childcare facilities
1B	501 - 1000	• Outer Ring Road • Adamstown Railway Station and surface park and ride car park • Surface Water Works • Further childcare facilities
2	1001-1800	• Construction of first primary school • Construction of first community centre • Link road to rear of Superquinn • Further childcare places
3	1801-2600	• Dedicated QBC bus corridor • Leisure centre with swimming pool • Phase 1 of Adamstown District Centre • Second community centre • Further childcare facilities
4	2601-3400	• Secondary school • Tandy's Lane Park • Third community centre • Further childcare facilities
5	3401-4200	• Doubling of Dublin - Kildare surburban rail line • Second phase of Adamstown District Centre • Further childcare facilities
6	4201 - 5000	• Second primary school • Fourth community centre • Central Boulevard Urban Park • Enterprise Centre • Further childcare facilities
7	5001 - 5800	• Celbridge Link Road • Airlie Park Leisure Facility • Fifth community centre • Tandy's Lane Local Centre • Central civic building • Further childcare facilities
8	5801 - 6600	• Third primary school • Tobermaclugg Local Centre • Sixth community centre • Further childcare facilities
9	6601 - 7400	• Third phase of Adamstown District Centre • Tobermaclugg Park • Seventh community centre • Further childcare facilities
10	7401 - 8200	• Second Enterprise Centre • Further childcare facilities
11	8201 - 9000	• Eighth community centre • Further childcare facilities
12	9001 - 9800	• Ninth community centre • Further childcare facilities
13	9801 - 10150	• Tenth community centre • Further childcare facilities

3. SUSTAINABILTY AND ADAMSTOWN

Sections 3.1 to 3.6 will examine six different types of infrastructure provision being made for Adamstown, i.e. that of community, transport, energy, water, information technology and waste respectively. Undoubtedly all of these will, in some way or other, have an effect on the sustainable use of space in Adamstown, both above and below ground, and therefore in Section 3.7 this will be discussed also.

3.1 Sustainable Community Infrastructure?

Achieving a sustainable community has been an underlying aim of the Adamstown project therefore it is not surprising that a great deal of forethought, in terms of design and planning, has been given to ensure the successful provision of a well-functioning social infrastructure. The first requirement must be the delivery of facilities within the built form, and in this respect it can be seen that Adamstown has made significant progress, aspects of which are outlined below.

(i) Education: Adamstown will have four Schools on three sites (SDCCPD, 2003). Three new Primary Schools (Adamstown Castle Educate Together, St. John the Evangelist, and Esker Educate Together, Figure 2) opened on September 5th 2007 and currently occupy the Adamstown Castle Educate Together school building. Alternative school buildings for the St. John the Evangelist National School and the Esker Educate Together National School are being built (SDCC, 2008a) and are shown in Figure 1. The Adamstown Post-Primary School (Figure 1) will accommodate a further 1000 pupils and is due to open in September 2009. It is both multi-denominational and co-educational.

Figure 2 Primary Schools in Adamstown Castle

(ii) Shopping and Retail: The town centre will incorporate 48 retail units, 9 restaurants, 2 public houses plus cafés/bars and offices (15,000m^2). These are expected to bring some 2500 new jobs to the area (SDCCPD, 2008).

(iii) Emergency services: The South Western Area Health Board advocated that at least one healthcare centre was required in Adamstown (SDCCPD, 2003). This is due to be located in Adamstown Central (SDCCPD, 2008) and the same development area will allow provision for the Garda (Irish Police). It is anticipated that a fire station may be required (the nearest alternative being 10 minutes away in Leixlip) and therefore an area has been set aside in Somerton for such a purpose (SDCCPD, 2003);

(iv) Childcare facilities: An average of one childcare facility per 75 dwellings will be provided according to *Guidelines for Planning Authorities,* GOI, 2001). A minimum of 1449 places are advocated for Adamstown (SDCCPD, 2003);

(v) Community Buildings: There will be 10 community buildings in Adamstown, some of which will be located within the town centre (Adamstown Central). This area will contain a library, an enterprise centre and several civic squares, in addition to a leisure centre, a swimming pool, an eight-screen cinema, a community centre and an inter-church place of worship.

Whilst these elements are essential to a community, the creation of a truly sustainable community requires more than just excellent built form (i.e. attractive boulevard streets, dwellings and open space) and provision of facilities - it requires steps to foster a community. As recognized in the Adamstown end of year report in 2007, this requires additional input on the part of the South Dublin Development Agency, the Adamstown Developers and the new community (SDCC, 2008a). The steps required include:

(i) Social housing and affordable homes provision: In accordance with *South Dublin County Council Housing Strategy 2001* Adamstown allows for 15% of all the housing in Adamstown to be provided as social/affordable (SDCCPD, 2003). [In 2008 a single applicant for an affordable house would need to gross less than €40,000/yr (gross before tax), the equivalent figure being €100,000/yr for two income households. Each year in ROI there are estimated to be around 6000 applicants for 650 available places leading to a waiting time of around 16 months (*per comms*)]. In 2006 all 635 units within Adamstown Castle sold within three weeks of the launch. First time buyers accounted for 55% of total purchasers, with 20% coming from investors and the remainder being those moving up the property ladder. An estimated 25% of potential buyers were non-nationals, highlighting the huge impact on the market of inward migration of workers to ROI in recent years (Krings, 2006). Affordability was based on people's ability to acquire mortgages, with 7+ times that of a borrower's income being readily available. In subsequent launches (as that of Adamstown Square on January 21st 2008) the long queues of buyers were absent - the reduction in demand being directly related to the downturn in the market and the reduced availability and size of mortgage lending. In November 2008 the cost of a 4 bedroom house had fallen to €425,000, down almost 20% on 2006 values (ironically a 20% reduction is a good approximation of that given on affordable homes in 2006). First floor duplexes had fallen from €385,000 to €345,000 in the same period (Lucan Gazette, 2008).

(ii) Community Liaison: A full time Community Liaison Officer was appointed to work in Adamstown in 2007 by SDCC's Community Department. This was seen as an important first

step in facilitating the emergence of a sustainable community (SDCC 2008a). Since this time significant steps in creating a sense of community in Adamstown have been made through public meetings; themed community nights and a community week (this included such themes as Wii night, cultural day, meet your neighbour night and salsa night); and Christmas parties, all of which are held in Adamstown's local school buildings (SDCC 2008c). Residents need also to be kept fully informed as to the progress of development and this is achieved in various ways, not least through the Adamstown website (www.adamstown.ie). The website provides up to date information on planning applications, strategy documents and design competitions (SDCC, 2008a). In addition it provides links to the neighbours discussion forum (www.neighbours.ie/adamstown).

(iii) Monitoring and evaluation: South Dublin Council commissioned Amarach Research to conduct surveys of new residents in Adamstown. (In October 2008 some 912 residential units were occupied in Adamstown). The aim of the study is threefold: to find out who lives there, what it is like to live there and the wishes of the residents regarding the future growth of Adamstown (SDCC 2008c). The results of this survey are yet to be released, although it is evident that the diversity of population and ethnicity is very wide ranging. This is not surprising given that the adjoining town of Lucan currently has more non-nationals than nationals (CSO, 2006). Such diversity is akin to that found in many areas in UK cities.

3.2 Sustainable Transport Infrastructure?

The Department of the Environment (DoE, 1997) stipulated that an increase in both the efficiency and use of public transport systems, as opposed to private motor cars, within Irish developments would facilitate a more sustainable future. In furthering this agenda *The National Development Plan 2000-2006* (NDP, 2000) outlined a six-year investment programme to: develop, extend and increase bus capacity; implement the Luas (metro system); quadruple the Kildare rail link to Heuston (Dublin's main railway station); and provide rail links through to Connolly (Johnson, 2001). Rail provision within the Adamstown Development is considered by Black et al (2006) to be part of the 'here and now' with respect to sustainable urban development, stating that the legacy of road-orientated urban planning and development around Dublin had already been seen to fail.

Disruption to commuters through the widening of the M50, the main orbital road around Dublin, to three lanes would not have helped in this matter. Adamstown railway station (Figure 3) took just over 12 months to build and was opened on 16th April 2007. Situated on the Kildare line, it provides Adamstown residents with a 20 minute commute into Heusten (Dublin's main rail station) - the Luas providing connection with other inner city areas. The Adamstown community is being developed around this railway station, the first privately built station since 1922. The transport interchange includes 100 covered bicycle parking racks (Figure 3); pick-up and drop-off areas for buses and taxis; and a park and ride facility for 300 cars situated 200 metres away. The SDZ required that two quality bus corridors (QBC) were provided in Adamstown, one north-south and one east-west (Figure 4); these now form part of the 151 and 25X bus routes that connect through to Dublin's city centre (SDCC, 2008a).

Figure 3 Adamstown Central Rail Station (showing bus stop, taxi rank and cycle racks)

Figure 4 Quality Bus Corridor (QBC) in Adamstown Castle

Enhanced opportunities for walking and cycling were highlighted as essential aims for achieving a more sustainable future in Ireland by DoE (1997). In addressing these aims the Adamstown SDZ (SDCCPD, 2003) sought to provide "a network of direct, safe, secure and pleasant cycle and pedestrian routes" and in so doing "maximize the opportunity for pedestrians and cyclists to access services and facilities", not least the local and strategic public transport network. The Adamstown cycling strategy (SDCCPD, 2005) provides finer details. The proposed route broadly consists of 1.5m cycle tracks situated on-road (north south may be integrated as part of QBC) and 3m wide tracks through the three parks (See SDCC, 2008b). The DoEHLG (2008b) reported Adamstown to be a sustainable exemplar in terms of its strategies for promoting cycling (e.g. one bicycle parking facility per dwelling) and walking (e.g. pedestrian accessibility is achieved by limiting block sizes to between 0.4 and 1.0 ha). The development is based on five and ten minute walking schemes respectively, i.e. 400 m to a local centre, of which there are two, and 800 m to the district centre and public transport system (Johnson, 2001, SDCCPD, 2003). Adamstown central, the main district centre, will prioritise both pedestrian and cycle movement. Undoubtedly the Adamstown development has reduced the need for the private motor car in line with policy. Although every effort has been made to avoid their domination within the development (SDCCPD, 2003), cars can still be accommodated and as such properly marked car parking spaces (one per dwelling, or two per dwelling with 3 or more bedrooms) are provided within blocks and on all roads and streets within Adamstown excepting QBCs. In addition, disabled parking is provided throughout. When completed it is estimated that the 24 km road network will contain 29 toucan crossings (7 others are possible), 7 pelican crossings and 2 staggered crossings all of which are wheelchair accessible (SDCC, 2008a), as are most homes. The finer details are given in *Adamstown: access for all strategy* (SDCCPD, 2006).

3.3 Sustainable Utility Infrastructure (Energy)?

Since the ROI signed the Kyoto Protocol on 29th April 1998, it has been committed to reducing carbon dioxide emissions (ROI contributes 0.2% of total emissions). The Irish government has set itself an ambitious target of 15% reduction by 2010, greater by 5% than that proposed in the UK. The publication of several key documents [*Green Paper: Towards a sustainable energy future for Ireland,* DoCMNR, 2006; and *White Paper: Delivering a sustainable energy future for Ireland,* DoCMNR, 2007] have outlined strategies for achieving these reduction through the adoption of sustainable energy strategies, i.e. renewable energy technologies and improvements in energy efficiency (DoCMNR, 2007).

Adamstown has reportedly adopted a sustainable approach to energy design, specification and construction practices (Noonan, 2006) and therefore is in line with such strategies. For example in terms of energy demands alone some 400 homes within the Adamstown Castle development were designed to be very energy efficient and achieved standards that complied with *Sustainable Energy Ireland's* (SEI) *House of Tomorrow* criteria (SEI, 2006). [SEI was launched in 2001 as an initiative to improve energy efficiency of homes in line with policy by use of grants – in Adamstown Castle 100 homes only were funded through SEI, the other 300 being funded through the developer alone, reportedly at little extra cost]. The designs were adopted early within the decision making process and included adoption of low carbon concrete and pre-cast panels fabricated to reduce emissions and waste throughout (Mahoney, 2007). In addition the building fabric elements exceed by 40% the standard building regulations in ROI These included elemental U-values of 0.20, 0.27, 0.25 and 2.20kW/m^2 respectively for roofs, walls floors, and doors and windows, such values being similar in magnitude to those specified in the 2005 UK Building Regulations (ODPM, 2006). Scandanavian pine doors and windows form part of a comprehensive system for natural ventilation, draught sealing and household security (SEI, 2006). Passive solar designs were integral in the designs in addition to separate water and heating circuits, the later being zoned (i.e. upstairs and downstairs heating can be operated individually) with timed temperature controls and individual radiator valves. All houses are supplied with A-rated boilers (e.g. Mynute 25HE manufactured by Vokera) according to the SEDBUK (Seasonal Efficiency of Domestic Boilers in the UK) standard and in most cases were sold with energy efficient A+ appliances, i.e. fridge freezers, washing machine and dishwasher. All homes offered for sale after January 1st 2009 will require an Irish Building Energy Rating (BER) certification.

In terms of energy supply most completed developments within Adamstown are supplied through conventional mains gas and electricity, a new 110kV electrical transformer being constructed on the western perimeter of the development. Both gas and electricity are metered, and each come from a single provider - gas is supplied by Bord Gaois and electricity from Electricity Supply Board. SEI funding was secured for undertaking a feasibility study to look at sustainable approaches to energy within Adamstown (SDCC, 2005). In terms of energy supply the outcome of this study could have been used to seek European funding (e.g. CONCERTO and THERMIE) in order to set up an Energy Saving Company (ESCO). However, it was not, and this is thought, in part, to be due to the nature of the Adamstown project (i.e. the economics are not favourable for low density development) and the Irish energy regulatory market. However adoption of a combined-heat-and-power (CHP) system for powering the schools and leisure centre on the Education and Leisure campus site was highlighted as a future possibility (ASG, 2005).

In addition proposals for a community heating system, supplied by 30% renewable energy, within Adamstown Central have been put forward, although the finer details have yet to be released. This goes some way towards achieving more security of supply (one of the key aims of the energy white paper) for heating requirements and this is very important for Ireland considering that 80% of the natural gas supplies originate from the UK, which itself is a net importer (DoCMNR, 2006). Interestingly, burning of turf for heat amounts to 4.3% of Ireland's energy supply currently, although such supplies cannot be considered renewable (Howley et al, 2008).

3.4 Sustainable Utility Infrastructure (Water)?

In terms of water demand there is little sign of reduced consumption beyond what could be considered normal practice. For example within Adamstown Castle (now almost complete) water demand reduction is achieved through the adoption of dual flush toilets (6 litre cistern), aerating taps and water efficient appliances, although power showers have been included instead of showers delivering a smaller water usage. A typical 3 bedroom town house will have 2 bathrooms (one with a bath and the en-suite with a shower), and a downstairs WC.

Adamstown has its water supplied from the new Lucan / Palmerstown High Level water supply scheme. The scheme was completed in 2004 and involved pumping treated water via

26 km of new pipeline from the Leixlip Water Treatment Plant to a new 40 megalitre reservoir at Peamount Hospital. Adamstown is split into three local Water Section Areas (WSA) and each of these is divided into smaller District Meter Areas (DMA) for water supply. It has been estimated that the demand will be 150 litres/person/day (McCarthy, 2005), and this is relatively high when considering available SD benchmarks. For example the Code for Sustainable homes in the UK (DFCLG, 2006) advocates a demand benchmark of 120 litres/person/day in order to achieve Level 1-2 (the lower levels) and 80 litres/person/day in order to achieve Levels 5 and 6 (the higher levels). In addition and unlike parts of the UK, domestic water is not metered and separate water rates (i.e. for supply of clean water and for sewerage) are not imposed.

In terms of stormwater ~67% of the Adamstown development has been designed to drain via culverts towards the Tobermaclugg stream (see Figure 1) close to the river liffey. The other 33% (including land from Adamstown Castle) drains toward Grifeen Valley sewer and Esker pumping station outside the eastern boundary. The culverts for storm drainage have been sized for a 100 year event. In addition attenuation of'first flush' storm water (i.e. that arising from cross connections after rainfall events) is via two underground storage tanks (2400 m^3 of combined capacity) which will subsequently drain into the Griffeen Tributary (Johnson, 2001). SUDS for stormwater management, has been advocated within Adamstown (McCarthy, 2008). The guidance given in CIRIA C521 (CIRIA, 2000) is being considered, although the finer details are not yet known. Most of Adamstown is located approximately 5 metres above the indicative flood plain and therefore unlikely to flood. However Tubber Lane has flooded previously and therefore the introduction of larger culverts (2.2 x 1.5m) should alleviate this downstream flood risk (McCarthy, 2008). In so doing substantial sustainability benefits have been gained for existing residents of this area.

Foul water is transferred from Adamstown to the Lucan, Clondalkin drainage system via the Tobermaclugg pumping station using twin rising mains and a gravity sewer. This new pumping station was constructed in 2006 and is located at the northern edge of the development in the new Tobermaclugg Park (McCarthy, 2006) - it is located 300 mm above the levels predicted for a 1000 year flood event. Design calculations for foul sewers were undertaken using WinDES software (incorporating a range of DWF values up to 147 l/s). Design flows were based on contributing areas rather than number of houses (maximum yield of 90 houses / units per hectare) and assumed an outflow of 1000 litres/house/day with a design flow of 6 DWF (McCarthy, 2004, 2008).

3.5 Sustainable Utility Infrastructure (Communications)?

In an attempt to future proof Adamstown for communications technology 'Smarthomes' infrastructure has been integrated throughout. A householder has the choice of two essential options (Gunne Homes, 2005):

- A bronze package option consists of a complete household cabling system for connection of: digital TV, telephone, broadband, PC networking, and multi-media points throughout the home via a linked central hub (a user-friendly type patch panel system).

- Silver and Gold packages include wiring for home cinema and audio, allowing for access to central radio, CD players and iPods throughout the home.

Information technology infrastructure provision forms a big part of the design of Adamstown, with most developments offering access to at least two telecom ducts.

3.6 Sustainable Approach to Waste Removal

Within the Adamstown development there are two types of waste collection system in operation: household waste and mixed recyclables. The collection bins for these, blue and orange respectively, come in two sizes depending on type of residence (240 litre for an individual dwelling and 1100 litre for apartments). A typical collection point for apartments is shown in Figure 5. Household waste is collected on a Tuesday and recyclables every other Friday. At present the nearest recycling disposal points for glass (white, brown and green) and fabrics/clothes is at the local supermarket car park, less than 1000m away from Adamstown. Domestic waste charges in Adamstown are levied at householders through an organized waste collection service for each dwelling, charges being made through the ground rent. The use of prepaid bin tags, a system by which only the amount of waste being sent to landfill is charged, operates in and around the Lucan area. This second method of payment contrasts with those used in the UK where a standard charge is levied as part of council tax fee. Electrical recycling in Ireland also reduces the tendency to landfilling; for example the Waste Electrical and Electronic Equipment (WEEE, 2002) Directive 2002/96/EC ensures that retailers offer a free take-back service for small consumer products (e.g. toasters, portable tape players, mowers, etc.). For much larger products an Environmental Management Cost (EMC) also known as 'producer recycler fund' is added at purchase.

Figure 5 Waste collection points for houses (left) and apartments (centre)

3.7 Sustainable Use of Space (above and below ground)?

Adamstown has made good use of space above ground, not least in the provision of open space which amounts to some 25 ha (15%) of the development area (Figure 1) and includes 4 major parks (10%), the biggest of which are Airlie and Tandy's Lane (Table 1). The €11 million commission for the design of these two parks has been awarded to Foley and Salles (an Irish-French partnership) following an international competition. Play areas amount to some 4% of open space allocation, a typical example of open space being shown in Figure 6. The Urban Design Manual (DoEHLG, 2008b) cited Adamstown as a sustainable exemplar in many areas of its design above ground, notably:

(i) The use of space, including private open spaces that add character to communal space.

(ii) Sense of ownership, the ability for developments to 'overlook' helps foster this and because they are well separated this gives

(iii) Privacy and a degree of security (Figure 7).

(iv) Discernable focal points for the town (i.e. Adamstown Central) where efficient use of space and higher density development (Table 1) will be achieved next to transport nodes (i.e. the train station), this being in line with national policy on Sustainable Development (DoE, 1997). In addition building heights will vary according to density, i.e. buildings will be no higher than 5, 7 and 10 storeys for low, medium and high density respectively.

(v) Hierarchy of space: streets are designed as 'places', rather than a network of roads for cars (e.g. surfaces on less busy routes are shared by pedestrians, cyclists and drivers, see Figure 6). Parking spaces and landscaping is well integrated, adding to the quality of the space and allowing for residential, rather than traffic, priority (Figure 6).

(v) 'Sense of place' is created through the construction of landmark buildings which are encouraged at key focal points throughout Adamstown. For example, in Adamstown Castle these include the grand main entrance (Figure 8) and the nearly completed 'Sentinel' building (Figure 9), both being highlighted in Figure 1. There are many lessons to be learned from the public realm being created in Adamstown and these will no doubt be captured in the *Adamstown Public Realm Design Guide* that is being created currently (DoEHLG, 2008b).

Figure 6 Quality of Space provision in Adamstown Castle

Figure 7 Privacy and a degree of security in Adamstown Castle

Figure 8 Entrance to Adamstown Development (Adamstown Castle)

Figure 9 The Sentinel building (Adamstown Castle)

In addition Adamstown has made good use of its underground space in several areas. For example:

(i) 900 underground parking spaces have been allocated within the higher density development of Adamstown Central.

(ii) Flood water storage tanks have been located underground and next to the pumping station for alleviation of flood water (see Section 3.4).

(iii) Utilities placement follows best practice and is very well documented. All utility infrastructures follow the same layout as the road system and where appropriate use colour coded ducts. Depth of location, capacity (diameter and flow rates and direction of flow for water pipes) and exit and entry points are all known. Sewers have a minimum pipe diameter of 225mm (design velocity of 0.75m/s for self cleansing) in perimeter roads and 600mm for connection to the pumping station (McCarthy, 2008);

(iv) 'Neutral carrier' multi-ducts have been adopted as part of the information technology (IT) infrastructure (SDCCPD, 2003) could be considered a more sustainable approach to underground space. [Neutral in this respect refers to the fact that any communications service provider (e.g. NTL, eircom, etc.) of which there are many in Adamstown, can use the ducts.]

Both *(iii)* and *(iv)* are vitally important in terms of future utility location (a major headache for existing urban areas) and their maintenance or upgrade.

4. CRITICAL REVIEW OF PLANNING, DESIGN AND DEVELOPMENT PROCESSES

During examination of the Adamstown development it has become apparent that several contributing aspects to the *Planning and Development* process are helping in the delivery of a 'sustainable community'. Their dissemination therefore is vitally important if similar developments being undertaken elsewhere in ROI or the UK, where sustainable communities are planned, are to succeed. As such these contributing aspects are discussed further in Section 4.1 and summarised in Table 4.

The various *Design Approaches* used for infrastructure provision are equally important as they have certain critical implications for achievement of a truly sustainable community both now and in the future. These design approaches (summarised in Table 5 in terms of opportunities seized and missed) are discussed in Section 4.2.

By aligning *'what if?'* questions with these design approaches in Table 5 it has been possible to broaden out the discussion to include possible future scenarios for the town. Such an approach is directly relevant to the Urban Futures research project, not least in terms of optimizing strategies for water utility provision - whatever the future may hold. This part of the table is not exhaustive, nor based on fact, but is used more as a tool to open up debate on the use of future scenarios as a tool for thinking 'outside the box' when designing and planning for possible future requirements of an urban development. A series of questions are posed relating to the future of Adamstown and its infrastructure provision when looking (say) 40 years hence.

4.1 Planning and Development Process

Clear dialogue between all actors has undoubtedly been a vital ingredient of the development process in Adamstown. In part this is related to the fact that the three developers, Castlehorn, Maplewood and Tierra Ltd., formed a consortium (Chartridge Developments Ltd) and was committed, early on, to a shared vision of developing a 'sustainable community'. This enthusiasm was filtered to other associated parties on their teams, including architects, engineers and landscape designers. As Mahoney (2007) states: "everyone bought into the process of delivering a sustainable community from an early stage". In the UK, lack of such dialogue within a similar sized 170 ha urban regeneration scheme resulted in SD opportunities being missed (Hunt et al, 2008). This significant barrier has been overcome for Adamstown with all developers being engaged in dialogue very early within the decision-making process. In addition the South Dublin District Council (SDDC) has provided strong early direction to the Adamstown development; as reported by Hunt et al (2008) such leadership will provide clear direction to all three developers and, moreover, this kind of leadership is vital to the delivery of SD. Such strong leadership may be due to the fact that Adamstown is the first new town on this scale to be built for more than 20 years in the RoI. Moreover it is the first SDZ to be built. Therefore its success is paramount to SDDC if such developments of similar scale are to be undertaken in the near future. In parallel to this the lessons being learned within Adamstown are being captured through new policy documents and therefore translation of lessons learned in design and planning process for new towns is being facilitated.

In terms of process these include the implementation of Adamstown as an SDZ and the delivery of a logically phased development whereby key infrastructure is in place before development is allowed to progress to the next phase. A high degree of information is being made available to the public as part of the development process. All Adamstown planning applications (including all proposals for transport and utility infrastructure) accompany SDZ applications and are housed on the Adamstown website with hard copies made available at the local library next to the local supermarket; these are updated as new planning applications are lodged. In addition Adamstown has an information centre which is accessible to all. SDDC produces yearly updates on progress in Adamstown; hard copies are delivered by hand to residents and soft copies are posted onto the Adamstown website. Five have been produced so far (see SDDC, 2005 – 2009). Transparency of such information is vital for the delivery of SD, not least because it allows for active public and community engagement, and this new knowledge can facilitate locally-derived solutions (Hunt et al, 2008).

It is clear that there is a very strong will for Adamstown to succeed and if it does it may reflect the blueprint for meeting future housing needs of a growing national population of young Irish and migrant workers in RoI.

Table 4 Important contributing aspects of the planning and development process

Actors	Lessons learned (actors involved)
C – Council D - Developers Pl - Planners P - Public	○ Clear dialogue between all actors (C, D, Pl P) ○ Willingness to commit to a shared vision of a 'Sustainable Community' early within decision making process (C, D, Pl) ○ Strong early direction/leadership from South Dublin District Council (C) ○ New policy documents drawn up through lessons learned (C, Pl) ○ Early implementation of an efficient SDZ planning system (C) ○ Phased development process to allow for infrastructure to be in place (C, Pl) ○ High degree of information made readily available within public domain (C, D, Pl, P) ○ High degree of community engagement (C, D, Pl, P)

4.2 Design Approaches and 'what if?' Future Scenarios for Adamstown

The Community Infrastructure in Adamstown has been designed to cater for all of the requirements one would expect of a new town. In line with policy it has been designed for high densities at the transport node and steps have clearly been made toward fostering a 'sustainable community' (e.g. through provision of social housing and affordable homes; community liaison; and monitoring and evaluation). When considering future scenarios for Adamstown, it is not unreasonable to suggest that communities of the future will have the same requirements of the built form, nor is it unreasonable to suggest that population density will increase not least around city centre urban environments (Glenn and Gordan, 2006). However, by asking 'what if' questions one can go beyond this type of analysis and make more extreme assumptions about a future world. For example what if the Adamstown community changed in the future, how much of what is built now would facilitate such a future world? Two extreme worlds could be those conforming to an idealised vision of a 'sustainable' community and a reversal of this trend by moving towards a 'gated' community, as shown in Table 5. By making such extreme assumptions it is possible to start to investigate the effects on a development such as Adamstown, and test whether the infrastructure provision designed and planned for today would facilitate such a world were it to exist in (say) 40 years time. Engineers can begin to examine whether such systems have the capacity to adapt to extreme change or whether such an end state would need complete regeneration. Moreover it allows engineers to examine these designs in order to see if such flexibility could be built into the infrastructure that is provided today.

Adamstown has made great steps towards designing and planning for a well-integrated public transport system, via its train station and QBCs, to serve the 30,000 new residents it will have when completed in 2016. In addition it has allowed for full integration of the motor car with adequate provision being given to cycling and walking. However using the same 'what if' questions one might envision Adamstown to be a 'no-car' community in 40 years time. Moreover one might envision a community that did not allow use of waste collection wagons or utilities companies to dig up any roadways or pavements. What would such a world be like and would it be possible based on the way Adamstown infrastructure exists at this time? Such moves would require alternative methods for utility provision, and specifically utility conduit placement, e.g. introduction of multi-utility conduits that would house all utilities for supply and disposal; these might then include pneumatic waste collection systems. If increased demand were experienced, for whatever reason, such restrictions could lead to expansion of supply solely through local generation or derivation (solar power, wind power, groundwater abstraction, rainwater harvesting and local storage, grey water recycling, and so on). Such local sourcing would suit either ends of the 'sustainability spectrum' referred to above: the ideal sustainability scenarios would encourage these practices and local sharing, whereas gated communities would seek these practices for security of supply. Moreover it may inevitably require a new way of thinking about how utility networks are designed. Traditionally utility networks are set out according to predetermined development boundaries, but what if developments were planned around predetermined network boundaries? Would such an approach improve efficiency of network designs, and moreover could people live in such a development without drastically changing there ways? Would it be possible to switch branches on and off in traditional or newly designed networks in order to match the requirement of a future community type (e.g. A and B in Table 5)? Adamstown has a distinct advantage when compared to other urban developments in that utility locations (including all entry and exit points) are known and documented, although not in a national GIS database.

Water is a free commodity in Adamstown currently, i.e. there are no water or sewerage rates and no water metering. In part this could be because rainfall is relatively high - 30 years of meteorological rainfall data at Dublin airport suggests an average of 740 mm rainfall/yr (Met Office, 2008) in the range 40-70mm year round, while its population is relatively small (circa 4 million) meaning supply can meet demand with relative ease. Therefore not surprisingly ways of minimizing demand and maximizing potential supplies (e.g. rainwater harvesting or greywater recycling) have not been sought in Adamstown. 'Pay-back periods', preferably small, are used as an incentive for adoption of such systems in the UK (i.e. money saved through reduction in cost of water supply and disposal is offset against investment capital required). Ironically these are not valid when domestic water supply and discharge is free and therefore justification for their adoption in Adamstown currently would need to go beyond this - it could be argued that this should be the case anyway. Notwithstanding this argument, the availability of water and the way it is supplied may alter considerably in the next forty years.

Table 5: Design approaches and 'what if?' scenarios for Adamstown

Sustainability	**Design approach /** ***Opportunities missed***	**Future scenarios: 'What if'?**

Provision of Community Infrastructure	○ Built form includes buildings that cater for the following requirements:
	  ○ E.g. Residential; Offices; Education; Shopping and retail; Emergency services; Childcare facilities; Community buildings; Library; Medical facilities; Fire service; Garda
	○ Population density varies (from high to low) with distance from the transport nodes.
	○ Fostering a 'Sustainable Community'
	  ○ Social and Affordable housing
	  ○ Monitoring and evaluating
	  ○ Community liaison
		○ Built form requirements are relatively unchanged
		○ Population density increases dramatically
		○ (A) Community becomes more 'sustainable'
		  ○ Physical boundaries do not exist;
		  ○ More local stewardship required (e.g. emphasis on local sourcing and recycling)
		  ○ A world where everyone has
		○ (B) Community becomes 'gated' - by necessity
		  ○ Security of boundaries and resources are required
		  ○ A world of 'haves' (inside the gates) and 'have nots' (outside the gates).

Provision of Transport Infrastructure	○ Public transport
	  ○ Train station
	  ○ Quality Bus Corridors (QBC)
	○ Private transport
	  ○ Cars and parking allowed, but do not dominate
	  ○ Cycle routes and parking points
	○ Walking
	  ○ Pedestrian friendly
		○ Public transport still exists and is powered by fossil fuels
		○ Private transport does not exist
		  ○ A 'no car' community
		  ○ Wider uptake of cycle routes
		○ Walking
		  ○ Very pedestrian friendly
		  ○ No waste collection wagons are allowed
		  ○ 'No-dig' policies are introduced

Provision of Utility Infrastructure	○ Utility pipes/networks
	  ○ Utility Placement
	    ▪ Traditional placement method used in design
	    ▪ Neutral multi-ducts for communications
	  ○ Utility Location/function
	    ▪ Utilities follow predetermined development boundaries and are located beneath roads and pavements, part of national network
	  ○ Engineering data
	    ▪ Cataloguing of all entry and exit points
	    ▪ Cataloguing of all pipe diameters depth of placement and capacity (i.e. flow rates)
		○ Utility pipes/networks
		  ○ Utility placement changes (changes occur)
		    ▪ Multi-Utility tunnels are adopted (contain all utilities inc. Pneumatic waste collection)
		  ○ Utility location/function (changes occur)
		    ▪ Development boundaries now follow predetermined infrastructure layout patterns
		    ▪ Branches of networks are switched on and off to facilitate community types (e.g. A or B)
		  ○ Engineering data changes
		    ▪ As previous but data now located on a GIS database for easy overlay of other site data

Table 5 (continued..)

Provision of Utility Infrastructure	○ Water (easily accessed and disposed of) ○ Water demands ▪ *No water metering* ▪ Wet toilet flushing (6 litre cisterns) adopted ○ Water supply (mains) ▪ No charges for domestic water supply ▪ Rainfall relatively high year round ▪ *No other supply (e.g. rainwater harvesting) or demand reduction measures (e.g. greywater recycling) considered* ○ Water discharge (mains) ▪ No charges for waste water disposal ▪ Design for 1 in 100 yr flood ▪ Large water collection tanks ▪ New pumping station ▪ Water treated off-site	○ Water - becomes a very precious resource ○ Water demands (reduced by necessity as population and national demands increase) ▪ Metering mandatory ▪ Wet toilet flushing using smaller cisterns (4.5 litre and less) and possibly 'dry' systems ▪ All drinking water bottled ○ Water supply (mains and non mains) ▪ Charges for domestic mains water supply ▪ Rainfall variability (flash floods) • Local supplies considered (e.g. rain/grey water, other) ○ Water discharge (mains) ▪ Charges for waste water disposal ▪ 1 in 200 yr flood likely ▪ Collected water re-used ▪ Water treated on-site ▪ Changes in demand alter flow rates for discharge and efficiency of pipes (some are now too big or too small), knock on effect for water quality?
	○ Energy (supply meets demand easily) ○ Energy demands (Low heat requirement) ▪ Improved building fabric ▪ Low energy using technologies ○ Energy supply (mains) ▪ Electricity (predominantly fossil based fuels) and gas; one supplier for each; 80% gas supplied from UK ▪ *No community heating/ cooling adopted* ○ Energy emission disposal ▪ High CO_2 emissions from fossil fuel combustion	○ Energy - cost and security of supply are vitally important ▪ Energy demands (Very low heat requirement) ▪ Much improved building fabric ▪ Low energy using technologies ▪ Energy supply (mains and local) ▪ Localised renewable energy supplies (PV, Wind, Solar etc) ▪ Community schemes adopted ▪ Energy emission disposal ▪ 100% Carbon neutral ▪ Reduction in other air pollutants Clean energy (e.g. No NOx CO, etc)
	○ Waste (taken away and sorted outside development) ▪ Two types of waste collected (recyclables mixed)	○ Waste – must be minimized as dumping is prohibited ▪ Waste sorted at source and every effort made to recycle all of it within development
	○ Technology ▪ Wired IT infrastructure in all homes	○ Technology ▪ The wireless age

Many 'what if' questions could be asked with regard to water and an envisioned future state, for example what if: demands increased (or decreased) considerably; water charges were introduced (supply and discharge); metering became necessary; rain patterns changed and 200 year floods were a regular occurrence? What effect would this have on Adamstown's network capacity and its efficiency (i.e. flow rates, water quality, etc.)? In addition how would the water requirements of community A or B met? Could / should it be from inside the development, i.e. could / should Adamstown supply its water and clean its dirty water from within (as opposed to allowing resources to flow into and out of the development)? Moreover could Adamstown's current infrastructure be adapted for such a requirement change? If not could / should such flexibility be designed in now? Such questions undoubtedly open up considerable debate on the robustness of utility network designs, not least when faced with various future scenarios. The ability of current generations to future proof this infrastructure, as mentioned previously, is highly important.

The series of 'what if' questions for energy are broadly similar to those of water, and this is not surprising due to the similarities in resource flow (i.e. supply, demand and disposal). However, in contrast to its demands for water Adamstown has made significant steps toward reducing those for energy, e.g. in terms of improved building fabrics (which when adopted early on did not cost significantly more than traditional build costs) and low energy use technologies. Unfortunately Adamstown still relies mainly on fossil based fuels for its energy supplies, some of which originate from the UK. Again the 'what if' questions can allow one to think beyond what is known now and ask such questions as: what if demand patterns change in 40 years time and there was a significant reduction in fossil based fuel allowance per user, due to the increase in national demand for energy and reduced availability of supplies? How could somewhere like Adamstown supply local clean energy in order to achieve security of supply (a specific requirement for community B) and a 100% carbon neutral development (a possible self-imposed requirement for community A)? In addition are such aims allied with each other, e.g. would the energy supplies look so very different from each other for each of these such future communities?

In line with the ethos of sustainable living what if dumping waste was prohibited also, could the infrastructure provided in somewhere like the Adamstown facilitate the community in sorting and recycling waste on-site, particularly if higher density living occurred? Lastly what if technology changes in a marked manner; can the infrastructure be adapted to cope? This is an interesting question because the developers of Adamstown, in an attempt to future proof IT, have adopted patch panels and Lan type cabling. However technology has changed so much, and in such a short space of time, that the introduction of a wireless age may see such cabling superfluous to requirements.

By looking at a snapshot in time, some 40 years hence, this discussion section has provided significant food for thought with respect to future scenarios and their infrastructure requirements for Adamstown. The questions, whilst derived using Adamstown, could be assumed generic to any urban development. The answers are not always straightforward and in some cases require significant research to be done. Fortunately many of them map well onto the aims of the Urban Futures research project being undertaken currently. Adamstown provides a perfect international test bed for such research and is to be used in conjunction with other urban futures case study sites located in the UK.

5.0 CONCLUSIONS

This paper has presented an overview of the Adamstown Development in RoI and outlined the steps being taken to design and plan for sustainability therein. It has been shown throughout the development process that much progress (in sustainability terms) has been delivered, or is planned for, and most notably the development is reported to be exemplary in terms of its use of space and provision of community facilities. In addition the provision of a well-coordinated public transport system (including a new train station and bus routes) and provision for cycling are all in line with sustainable policies for transport. Moreover both of these examples show that many positive steps are being made towards achieving the goal of a sustainable community in Adamstown. When analysing the planning and development processes adopted in Adamstown it is apparent that the presence of a shared vision, early involvement from all parties (i.e. Council, Developers, Planners and Community) and designs based around local priorities, have been significant contributing factors. Such findings resonate well with previous research conducted using the Eastside urban regeneration project in the UK (Hunt et al 2008).

Sustainable provision for water and, to a lesser degree, energy could have gone farther in Adamstown. For example opportunities for maximising local water supply (e.g. rainfall harvesting), local energy supply (e.g. renewable) and minimising water demands (e.g. through end user technologies and greywater recycling) have been missed. Such a shortfall may be to the detriment of Adamstown, although this all depends on what the future holds. Envisioning future requirements for a development can be facilitated by using a series of 'what if?' questions. Such an approach has been adopted within this paper in order better to understand future infrastructure requirements. Further research will allow for novel solutions that break the current paradigms to be generated and make future proofing more easily achievable. Adamstown and other UK based sites provide the urban futures research team with significant opportunities to nvestigate (i) what infrastructure options are available within a future scenario, should they be required, and (ii) how these options can be optimised to achieve the most sustainable outcome.

6.0 ACKNOWLEDGEMENTS

The authors wish to thank the EPSRC for their support during this second round of sustainable urban environments (SUE2) funding under grant number EP/F007426/1.

7.0 REFERENCES

Acts of the Oireachtais (2000). The Planning and Development Act 2000. http://acts.oireachtas.ie/index.html

ASG (2005). Update report on feasibility study into sustainable energy measures for Adamstown. Adamstown Steering Group, 21 June 2005. Pp3

Black D, Boyle M and Mac Domhnaill D (2006). Getting Around. *The Official Journal of the Irish Landscape Institute*. Winter 2007. Pp ??

CIRIA (2000). Sustainable Urban Drainage Systems: Design manual for Scotland and Northern Ireland. CIRIA C521 Pp 126

CSO (2006). Census of Population Interactive Tables 2002-2006. Central Statistics Office Ireland. http://www.cso.ie/px/

DFCLG (2006) Code for sustainable homes, a step change in sustainable home building practice. Department For Communities And Local Government London, UK pp31

DoCMNR (2006). Green paper: Towards a sustainable energy future for Ireland. Department of Communications, Marine and Natural Resources. Pp112.

DoCMNR (2007). White paper: Delivering a sustainable energy future for Ireland. The Energy Policy Framework 2007-2020. Department of Communications, Marine and Natural Resources. Pp70.

DoE (1997). Sustainable Development. A Strategy for Ireland. Department of the Environment. Government publications, Dublin, Ireland. Pp267

DoEHLG (2002). Making Irelands Development Sustainable: Review, Assessment and Future Action. Department of Environment, Heritage and Local Government. Pp 12

DoEHLG (2008a). Sustainable Residential Development in Urban Areas. Consultation draft guidelines for planning authorities. Department of Environment, Heritage and Local Government. Pp 54

DoEHLG (2008b). The Urban Design Manual. A companion document to the Draft Planning Guidelines on Sustainable Residential Development in Urban Areas. Department of Environment, Heritage and Local Government. February 2008. Pp 123

Glenn and Gordan (2008) State of the Future. 12 years of study and analysis on The Millennium Project. CD Rom, Pp 6300

Gunne Homes (2005). Adamstown Castle: Life as it should be. Pp 31

GOI (2001). Childcare facilities: Guidelines for planning authorities. Published by the Stationary Office, Government of Ireland. Pp 20

Griffin T (2006). The Property Valuer. Special Issue: 2006 Property Survey. Vol.26, No. 1. January 2007. Pp36.

Howley M, Ó Gallachóir B, Dennehy E and O'Leary F (2008). Renewable Energy in Ireland: Focus on wind energy and bio-fuels. Energy Policy Statistical Support Unit. Pp 36.

Hunt DVL, Lombardi DR, Rogers CDF and Jefferson I (2008). Application of Sustainability Indicators in Decision-Making Processes for Urban Regeneration Projects. *Engineering Sustainability*, Proceedings of the Institution of Civil Engineers, **161**, 1, p.77-91.

Irish Statute Book (2000). Adamstown Strategic Development Zone. Part IX. *Acts of the Oireachtas.* Produced by the office of the attorney General. http://www.irishstatutebook.ie/acts.html

Johnson, D. R. (2001). Inspectors report on Adamstown Strategic Development Zone: Draft Planning Scheme. Volume 1: Assessment. Pp 477

Krings, T (2006). Labour Migration to Ireland. Translocations: The Irish Migration, Race and Social Transformation Review. *Translocation* **1, 1.** Pp 191-195

Lucan Gazette (2008). Adamstown: Starting from €345,000. In M50 property section of Lucan Gazette, Lucan, Co. Dublin, Republic of Ireland, November 2nd 2008.

LAP (2001). The Adamstown Local Area Plan.

Mahoney, J (2007). Adamstown: A new way of delivering a sustainable community. *Journal of Irish planning Institute.* Issue 17, Spring 2007. 19-38.

Martin BS, Morton,KM, Fitzpatrick Associates and Colin Buchanan and Partners (1999). The Strategic Planning Guidelines for the Greater Dublin Area. Pp162

McCarthy PH (2004). Adamstown Castle: Phase 1 housing, Services Report. PH McCarthy and Partners. June 2004. Pp 47

McCarthy PH (2005). Adamstown Water Supply Scheme. Report by PH McCarthy Consulting Engineers issued on March 2005.

McCarthy PH (2008). Adamstown District Centre. Adamstown Development Area 11, January 2008 ASDZ Services Report, Pp44.

McCarthy PH (2006). Tobermaclugg Pumping station and Stormwater storage tank, Report number 20060512. PH McCarthy Consulting Engineers, Dublin 14, Ireland. pp105

Met Office (2008). 30 year averages (rainfall data 1961-1990). The Irish Meteorological Service online. http://www.met.ie/climate/dublinairport.asp

NDP (2000). Ireland's National Development Plan 2000 – 2006. Guide to funding under the NDP and Community Support Framework. www.ndp.ie

Noonan, L (2006) People who live in green houses. The Sunday Business Post. 1st October 2006

ODPM (2006) The Building Regulations 2006: Conservation of Fuel and Power in NewDwellings Part L1A. Office Of The Deputy Prime Minister, London, 2006, p. 39.

Porter EJ and Hunt DVL (2005). Birmingham's Eastside Story: Making steps towards sustainability? *Local Environment* **10** (5):525-542.

SDCC (2005). Adamstown Strategic Development Zone. Annual report. January. The Adamstown Planning Team South Dublin County Council. Dublin, Ireland. Pp16

SDCC (2006). Adamstown Strategic Development Zone. Second annual report, January. The Adamstown Planning Team South Dublin County Council. Dublin, Ireland. Pp16

SDCC (2007). Adamstown Strategic Development Zone. Third annual report, January. The Adamstown Planning Team South Dublin County Council. Dublin, Ireland. Pp16

SDCC (2008a). Adamstown Strategic Development Zone. Fourth annual report, January. The Adamstown Planning Team South Dublin County Council. Dublin, Ireland. Pp16

SDCC (2008b). Proposed Adamstown Cycling Strategy

SDCC (2008c). Adamstown Residents Survey. South Dublin County Council. Pp 10

SDCCPD (2003). Adamstown Strategic Development Zone Planning Scheme. South Dublin CountyCouncil Planning Department. Dublin, Ireland. September. Pp126

SDCCPD (2005). Adamstown: Cycle Links strategy, Final Draft. September. Pp 16

SDCCPD (2006). Adamstown: Access for all Strategy, June, Pp 10

SDCCPD (2008). EIS for proposed district centre (phase 1) at Adamstown, Lucan, Co Dublin. South Dublin County Council Planning Department. Dublin, Ireland. SD08A_0002, January. Pp66

SEI (2006). House of tomorrow: Building for the future. Sustainable Energy Ireland. Pp11

Tyrell, F (2008) New town centre for 21st century in west Dublin

WEEE (2002) .Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

How does a regional town make successful sustainable urban design decisions

Prof. Rachel Cooper, Naomi Pemberton-Billing

Lancaster University, UK

This paper explores how decision-trees can be used during the urban design decision-making process to facilitate the sharing and storage of information and data relevant to the process. The case-study conducted has identified the current process and challenges faced and enabled us to develop with the help of practitioners an evaluation of current decision-making using decision-tree modelling. The research involved interviewing a wide range of practitioners across disciplines, to capture methods of working, sharing and storing of data and information. This has included individual interviews and various group discussions around the table.

The research was conducted in conjunction with the Lancaster and Morecambe City Council and focused on an area currently undergoing major re-generation in the West-End of Morecambe. The West–End is perceived by the Lancaster City Council as being fundamental to successful expansion of the Midland Hotel regeneration project which is the driver for regeneration of the whole of the Morecambe area. There have been limited funds available to the project team involved in the West End of Morecambe and much of the work has necessarily considered cost and sustainability. The regeneration team have therefore been keen to embrace suitable methods to harness, share and manage the important knowledge generated during the urban design process in order to improve the future of the area under generation.

Decision-trees were drawn from completed regeneration work in the west-end, they showed the variety of decisions that had been made by those involved and clearly emphasised the fact that much of the information and data related to important decisions had not been captured in any meaningful way. In most cases the only method for retrieval of the information was by memory recall by those present at the meetings. One of the key findings from the research was that when members of staff left, who had been responsible for decision-making, they left a gap in knowledge/information.

The results of the research show the benefits that can be achieved using decision-tree analysis in a small focused area to ensure that important data and knowledge/information generated during the urban design decision-making process are collected and stored for future use in suitable ways. The findings also highlight the problems associated with the loss of important information/knowledge that currently exists during the urban design decision-making process.

Keywords: decision support, urban design, urban regeneration, urban sustainability, knowledge management

1 Introduction

The first sections of this paper review the literature on the urban design process showing the confusing nature of attempting to understand what it actually is and what it means to the wide range of people involved and the literature on decision-making theory. The paper then goes on to review some commonly used decision-making tools and techniques including decision-tree analysis and explains its relevant importance to complex decision-making and why it has been chosen to be tested out in this case study.

The final sections of the paper present the research conducted into the sustainable urban design decision-making process in the regional coastal town of Morecambe in the North West of England. The research conducted compares the sustainable urban design decision-making process identified in Morecambe to the Urban Design Decision-making process model developed by Boyko et al, 2005. It goes on to examine how decision-making might be improved in Morecambe using decision-tree analysis in order to test the author's hypothesis 'that decision-trees could identify the points at which decisions are made and by who during the sustainable urban design decision-making process and analysis could highlight the relative level of importance of decisions thus enabling those responsible for decision-making to prioritise the allocation of appropriate resources to the area(s) concerned'.

The research remains incomplete and two further investigations will be conducted to supplement the research conducted to date.

2 The Urban Design Process

The process of urban design which results in an achieved outcome - whether it be the building of an individual structure or the regeneration of a whole area - involves large numbers of stakeholders who share responsibility for decision-making in that process. The level of involvement of each stakeholder is variable and is highly dependent on the nature of the project concerned and the interest of the individual stakeholder (Boyko et al 2005; Greed and Roberts 1998). Many of the stakeholders/professionals involved in the urban design process – lawyers and economists to name two - do not consider themselves to be urban designers however, their input and expertise form an integral and vital part of the urban design process (Schurch 1999).

There are a variety of theories as to what the urban design process looks like (Boyko et al 2005; Design Council, 2006). The majority focusing on the key qualities of the essentials necessary for achieving good urban design in terms of the achievable goals and principles (Jacobs, 1961; Punter, 1990). Punters work examines various literature on the subject and a range of individuals views, he concludes that the work of Jacobs, 1961 and Lynch, 1981 are responsible for the thoughts and principles of many including the Prince of Wales and the Urban Design Group (Punter 1990).

Defining urban design as a process is problematic as it could be suggested that each individual, each stakeholder even, has their own process of involvement in the urban design process. Despite this, many attempts have been made to define the various stages and steps involved in urban design. An early attempt, although not referred to as an 'urban design process' drawn in 1972 by Fraser Reekie a professional architect and town planner - identifies four stages in what he describes as 'the process of design in the built environment'. It is made up of 3 key elements – Planning, Urban Design and Building Design (which, he asserts, cannot be separated as each impacts on the other) and 4 key stages – Brief, Analysis, Synthesis, Implementation and Communication. Reekie recognises that the urban design process is complex and requires consideration of effective design techniques and research into the psychology of thought and the decision-making that takes place at each stage.

Brief - Clarification of requirements, possibilities and constraints research and investigation

⇓

Analysis - Sorting, evaluating and coordinating of information and specialists' contributions

⇓

Synthesis - Progressive production of designs to viability testing and checking recycling

⇓

Implementation - presentation of final, complete design physical realisation

Communication Verbal and graphic conveying of ideas, opinions and queries

Fig.1 Design procedure in urban environment (Reekie 1972)

His model appears to be linear and it is widely recognised today that this process is much more iterative in reality, requiring those involved to regularly return to earlier stages in the process in order to review the design (Rowley, 1994; Miller, 1995; Boyko et al 2005).

Whilst there are problems with this early model Reekie importantly identifies that the capture of the knowledge held by stakeholders in the decision-making process is fundamental to the success of any design in the urban environment. This opinion is one which remains held by many in the field of urban design today (Cuthbert, 2004; McGlynn, S, 1994). The author asserts that in order to improve the urban design process that decision-making, it's theory and applications relevant to urban design require further investigation. The following section is a short literature review of decision-making theory.

3 Decision-Making Theory

Decision-making is a subject which has been written about for centuries - in 399 BC Soctrates was sent to his death – the outcome of a trial based on the decision-making powers of 500 Athenian citizens; in the 9th century the Hindu-Arabic number system introduced which includes zero began circulating and stimulating mathematics which was then further developed by Omar Khayyam in the 11th century – (Buchanan and O'Connell, 2006). Decision-making is involved in just about every field including economics (Bentham 1924/1987) Mathematics and computing (Huber, 1981), and politics (Pfeffer, 1981). However, it was during the 1960's that an understanding of business decision-making theory first developed in response to the growing nature of global business and was aimed at identifying how and when decisions are made within complex organisations by management and others responsible for decision-making (Prusak, 2001).

Simons' Theory of Decision-Making (Bounded Rationality)(Simon,1967) is one of the most popular and widely used models in the teaching of decision-making theory including planning theory (Faludi, 1973).

Herbert A Simon was a distinguished psychologist (Nobel Prize Winning, 1978) and lecturer in Economics at Carnegie Mellon University. Simon's theory attempts to define a method for rational decision-making which can optimise decisions made under various different circumstances including those of uncertainty. Simon's theory is based on the assertion that all decisions exist on a continuum with two clearly defined categories of decision-making: - programmed decisions (repetitive and routine) at one end of the spectrum and non-programmed (novel, unstructured decisions) at the other end. Each of these categories is very different and requires appropriate methods and tools for managing the decision-making that takes place.

Despite the application of a structure such as this it is sometimes the case that decisions combine elements of both categories of decision-making as life is invariably complex. In taking account of this fact Simon's theory of decision-making is applicable to a wide variety of organisations and businesses. Decisions involving large numbers of people are complex, De Michelis, 1996 asserts that group decisions have a high 'social' nature which naturally involves extensive conflicts of interest including differing visions, interests, relations and influences the management of group decisions therefore requires tools and techniques appropriate to the setting to ensure that decisions are optimised. The diagram below shows the two approaches described above and shows how they differ: -

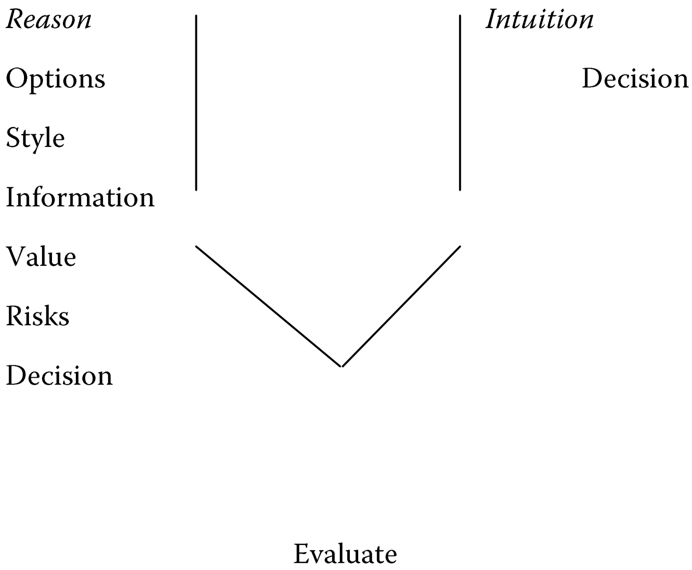


Fig. 2 Two categories of decision-making *(Reiss, 1995, p.173)*

Reasoning involves many stages and can take a great deal of time and effort, whereas intuition involves decision-making based on what is believed to be known already, it may take some time to evaluate this information but there are far fewer steps involved in coming to a decision.

Simon's theory of decision-making shows four main iterative phases which though appearing to be linear is not.

The following table summarises Simon's theory:

Phase 1 INTELLIGENCE	Searching the environment for conditions calling for decisions
Phase 2 DESIGN	Inventing, developing, analysing possible courses of action. Involves processes to understand the problem, generate solutions and testing of solutions for feasibility
Phase 3 CHOICE	Selecting an alternative or course of action from those available. A choice is made and implemented
Phase 4 REVIEW	Assessing past choices

Table.1 Simon's Phases of decision-making *(Simon, 1967)*

There are many other explanations of 'decision-making' and 'decision-making systems' including those developed in respect of multi-criteria decision support systems (DSS) Bahl and Hunt, 1984; the Gorry and Scott-Morton grid which classifies decisions in terms of problem structure and management level, Gorry and Scott-Morton, 1971; the garbage can model described by Cohen, March and Olsen, 1972 where decisions made are relative to the knowledge of the people making the decisions; rational decision-making theory which asserts that all decisions are made from known and quantifiable data (this is rarely the case, but the theory is widely used especially in accountancy practice and is best applied to tactical and operational levels of management where there is less uncertainty involved (Little, 2002); and the multi-perspectives approach which attempts to encompass all views on a subject which Mitroff and Linstone, 1993 have adapted from unbounded systems thinking in which all problems are seen as being part of another problem.

Decision-making or choosing between alternatives lies at the heart of all management functions regardless of the business or organisation involved (Lucy, 1997; Leavitt, 1988;). The management team in any organisation are responsible for problem solving that will ensure negative effects and risk are reduced and full advantage is taken of opportunities. The core management functions that take place in any organisation are planning, motivation and leadership, organising/coordinating and control (Cyert and March, 1963).

Decision-making takes place within each of these functions at differing levels within an organisation whether strategic, tactical or operational. Each decision, depending on the circumstances, requires different information. Some decisions are made using the judgement of the individual rather than quantitative data. These heuristic or rule of thumb decisions are subjective rather than explicit and are a fundamental part of organisational decision-making theory: -

> *"Decision making is an iterative process and although it is useful to separate out the various phases in order to discuss them, very few decisions are taken in this neat, logical sequence. There is feedback, inter-relationships between decisions; there is flair, intuition, judgement and creativity"*
>
> (Lucy, 1997, p.140-141)

Organisational decision-making also depends on the structure of the organisation. All organisations are formally structured in the first instance by those responsible for setting them up. There are directors and then the relevant departments necessary for the smooth running of the business such as marketing, accounts, personnel etc. However, over time, less formal relations develop amongst those working within the organisation as people become familiar with each others. Some organisations are hierarchical or pyramid shaped with several management levels. Decisions for action to be taken are usually centralised and passed down through the different management levels for implementation. Information about actions taken is then passed back up the chain of command. This invariably takes time and can often be frustrating and the cause of intense dissatisfaction amongst those lower down the organisational hierarchy. Other organisations are 'flat' or less hierarchical with fewer levels of management thus enabling information to flow more easily. This type of structure is generally seen in small to medium sized firms (Mintzberg, 1979).

With either type of organisation decision-making can be centralised or de-centralised with delegated authority for decision-making given to individuals within departments however, the decision-making process in whatever situation (including urban design projects, Boyko et al 2005) has common actions, whether long term (strategic) or short term (tactical) it is these common actions that form the base-line for most decision-making theories. Reiss identifies the steps in the decision making process as follows: -

Identify Problem

Establish Criteria

Select Alternative

Gather Information

Evaluate Alternatives

Select Compromise

IMPLEMENT DECISION

(Reiss, 1995, p.174)

These steps are common to all disciplines and similarly apply to simple and complex problem areas. However the decisions that are made at each stage require information, knowledge and/or data. At a base level decision-making is a human function that requires assimilation of a combination of known data and information and consideration of a number of human factors including legitimacy, shared understanding/beliefs (tacit/explicit), psychology, emotions, interpretation, trust and different individual or group levels of expertise that can affect the ability to share information and knowledge around organisations. It is widely recognised that these factors require careful consideration as they are an integral part of the successful management of knowledge (Kelly, 2007; Courtney, 2001; Filip, 2008).

Understanding decision-making has become increasingly important to organisations and this has led to the development of a wide range of tools and techniques to assist with organisational decision-making. The following section discusses some readily available tools and techniques.

5 Decision-Making Tools and Techniques

There are a wide range of decision-making tools and techniques available. Table 3 lists some common decision-making tools and their current fields of use.

This table provides only a small sample taken from the literature of the tools and techniques available, others can be seen in Brady et al, 1997.

Table 3

Tool/Technique	Use	Field Used In	Authors
Cluster Analysis	Use of large-scale Databases to model drug use and prescribing	Healthcare Management	Delesie and Croes (2002)
Decision-Tree Modelling	Transport simulation and Forecasting	Sustainability	Zachariadis (2005)
Remote Sensing and Geographical Information Systems (GIS)	Modelling of large complex eco-systems for analysis and management	Eco-System-Based Urban Natural Resource Management	Zhang et al (2000)
	Poverty Identification, national development planning and decision-making	United Nations Development Programme - Asia Pacific Region	www.apdip.net /projects/undp /np05/ view
BREEAM	BRE Environmental Assessment Method	Use for assessment of building quality setting standard for best practice in sustainable development	www.breeam.org
PETUS (Practical Evaluation Tools for Urban Sustainability)	Decision Support System providing shared understanding amongst stakeholders	Sustainable Urban Development	Jones and Patterson (2007) www.petus.eu.com
Managerial Psychology	Understanding people, their values, beliefs, attitudes, feelings, behaviour and sense of reasoning.	All Fields	Leavitt, H.J (1988)
Organisational Theory & Behaviour	Structure of organisations and it's effects on behaviour and function of those working for it	All Fields	Lucey, T (1997); McLeod, R (2001)

The following section examines the application of those tools identified above as being applicable and suitable for use in the area of Urban Design Decision-making.

6 Tools and Techniques for use in Sustainable Urban Design Decision-Making

As we have seen in section 2 many attempts have been made to identify the urban design process (Boyko et al 2005; Varkii, 1997; Shirvani, 1985) and there are a range of suggestions as to what urban design is/is not and the elements that it comprises (Carmona et al. 2002; Taylor, 1999; Barnett, 1982; Schurch, 1999; Rowley, 1994;). Within all of these discussions the complexity of decision-making and the complexity of sharing information around those involved are often clearly identified as being problematic with few notable recommended suggested solutions (Carmona et al, 2002; Boyko et al, 2006; Tiesdell, 2002; McGlynn and Murrain, 1994). These are practice based solutions (with the exception of Boyko et al, 2006 who have developed a 'legacy archive' the purpose of which is to store important information and data relating to sustainable urban design decision-making and the urban design process. This legacy archive will be made available to everyone involved in a project and will ensure that everyone shares the same understanding and data it will also be made available for future use) and do not offer recommendations for the management of the information/knowledge generated during the process. The author asserts that what is missing is the combination of practice based solutions with appropriate tools and techniques to assist with decision-making.

In the UK the government has been widely involved in up-dating the planning system and planning policy guidance (see www.communities.gov.uk). Although some substantial improvements have been made which include 'Capacity Check' to audit the urban design skills available within an organisation there are things which could be done to benefit the long-term impact of sustainable urban design decision-making. In New Zealand for example the government have dedicated the web-site of the Ministry for the Environment (www.mfe.govt.nz) to improving and informing successful urban design and management of urban design actions. This guidance provides all practitioners with helpful support on Research and Analysis, Public Participation Tools and Techniques, Tools for raising awareness of environmental quality and urban design issues, planning and design tools and implementation tools. There is a similar web-site in Vancouver, although not as comprehensive and detailed in the advice/guidance given it goes someway to help improving understanding of the importance of good urban design it is available at

www.Vancouver.ca/commsvls/planning/UDP/UDP.html

Urban design practitioners make decisions based on available facts and figures (. This, in combination with their own area of expertise, interpretation and understanding of the environment and individual circumstances that prevail for each project, lead to decisions being made. The available data is often very subjective and may involve having to make many decisions under conditions of uncertainty. During the sustainable urban design decision-making process large numbers of professionals are involved each with their own individual understanding and interest in the problem area. It is therefore vital that managers and decision-makers practicing in this field have the necessary tools and techniques to facilitate the sharing of information/knowledge between those involved to enhance decision-making under such circumstances and that we consider appropriate methods of working to maximise their potential.

Courtney, 2001 suggests an example of one such tool in the form of a Decision-Support System Paradigm. His paradigm considers how decisions are made, and embraces the multi-perspectives approach to include a combination of technical and social perspectives (Mitroff and Linstone, 1993). Courtney also recognises that this work is only the beginning and emphasises that further in-depth development of tools and techniques capable of adequately solving the maze of problems that exist for urban designers is much needed.

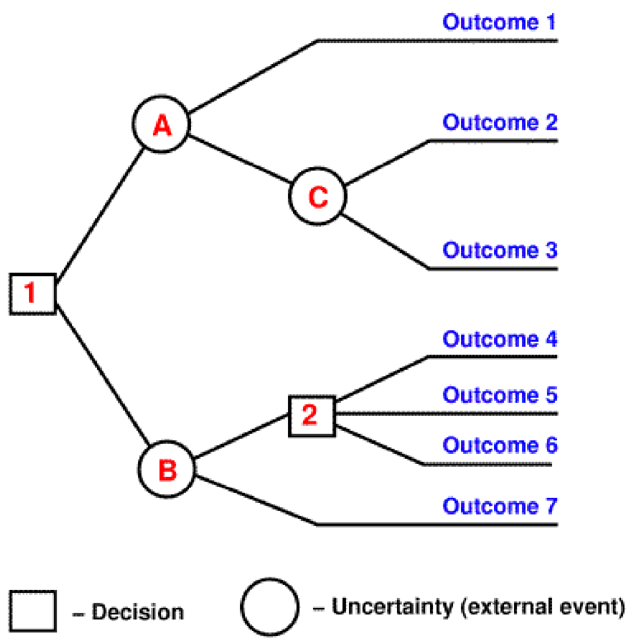
There are various papers in the literature that discuss urban design and the complexity of decision-making and the difficulties associated with the management of knowledge shared and generated by the process (see examples above) however, the author asserts that there are few obvious suggested solutions/tools that cover both aspects. However, some of the research papers on decision-making when discussing sustainability examine both area's and show that various methods have been used tested with differing degrees of success (Zachariadis, 2005; Courtney, 2001; Stoeglehner and Naradoslawsky, 2007; Puy, 2008). These and others are discussed in more detail in the chapter/section on Urban Design and Sustainability.

The focus of this research has been to attempt to develop a suggested solution to this problem and the author asserts that decision-trees could effectively be used because of their diverse applications which mirror the diversity of the urban design environment: -

6.1 Decision Trees

In decision theory and decision analysis decision-trees are graphs and/or models which depict the steps or stages involved in making decisions and their possible outcomes and are constructed to help with decision-making. They have been used successfully in both qualitative and quantitative studies and their origins can be traced back to the 1950's. They can be huge and complicated structures, however if used effectively they can be an excellent pictorial tool for enhancing decision-making within an organisation. Decision Trees not only show the decision-making route but also identify thought processes, mind sets and decision-patterns whilst ensuring that each stage is tracked and progressed appropriately.

The following is an example of a decision-tree.



Decision Tree. Figure. 3

(The squares conventionally denote decision points and the circles denote outcomes)

The events shown by Decision-trees are inter-related they can include probabilities of events occurring and are evaluated using anticipated rather than actual values.

Decision-tree analysis is extensively used in the area of information systems to map stages and steps in various processes including programming languages and decision-support tools (Aitkenhead, 2007; Sungjoo, L, 2007). They have also been used successfully in the monitoring of and prediction of intruder behaviours in connection with computer system intrusion attacks (Bouzida,Y and Cuppens, F, 2006). In medicine, decision-tree analysis has been used to evaluate the psychological stages of improvements for brain surgery patients and in predictive modelling of protein stability changes in mutated cells (Huang, L.T et al, 2007). In other area's decision-trees have been used in marketing to calculate the expenditure of marketing research (Bass, 1963). Decision-Trees have also been widely used in the area of sustainable urban development (Zachariadis, 2005; Boitsidis, 2006; Byrd and Gustke, 2007).

The table below lists some examples of the uses of decision-tree analysis

Area of Use	Use + Type of Anlysis	Outcome	Refs.
Medicine	Evaluation of Women's decision to have a Hysterectomy Qualitative and Quantitative	Successful prediction (90% accurate) of decision to have a hysterectomy -	Wu, S.M; Chao Yu, Y.M; Yang, C.F and Che, H I (2005) Decision-Making Tree for Women Considering Hysterectomy Journal of Advanced Nursing 51 (4) pp.361-368
Surveillance	Monitoring of break-in to computer sytems Qualitative and Quantitative	Understanding of behaviour patterns of intruders, monitoring and prediction of targets	Bouzida, Y and Cuppens, F (2006) Neural Networks vs Decision-Trees for Intrusion Detection IEEE/IST

			workshop on Monitoring, Attack Detection and Mitigation Tuebingen Germany
Medicine	Prediction of Protein Stability in mutation using decision-trees Quantitative	Use of large datasets to analyse protein and successfully predict the value of changes in protein stability	Huang, L.T (2007)
Computer Science	Decision-Trees vs algorithmic or neural network alternatives	Successful analysis of large data sets using large numbers of variables	Aitkenhead, M.J (2008) A co-evolving Decision Tree Classification Method in Journal of Expert Systems with Applications Vol.34 pp.18-25
Sustainable Development	Assessment of alternative models for sustainable transport in Europe	Transport simulation and forecasting	Zachariadis, T (2005) Assessing Policies Towards Sustainable Transport in Europe: an integrated model Energy Policy 33 pp.1509- 1525
Ecology	Management of population of endangered species Qualitative and Quantitative	Prediction of impact of various elements (pollution, vulnerability) on populations	Drechsler, M and Burgman, M.A (2004) Combining Population Viability Analysis with Decision Analysis Biodiversity and Conservation 13 pp.115-139

In terms of the complex decisions that take place in urban design, the author asserts that the use of decision trees could potentially facilitate comprehension of the decision-making environment. A decision tree could be used at each stage in the process to demonstrate the complex decision-making that takes place and provide a pictorial representation of large amounts of data and information, which would be easier to interpret than pages of written text. Estimated values could be assigned to decisions in each decision-tree in order to make qualitative data and information more easily quantifiable (not quantitative) in terms of their value to the urban design decision-making process.

The author's hypothesis is that simple decision-trees could be drawn to identify the points at which decisions are made and by who during the urban design decision-making process. Analysis of the decision-trees could help to highlight the level of importance of certain types of decision within the urban design process and enable those responsible for decision-making to prioritise the allocation of appropriate resources to the area(s) concerned.

The information and data captured from these various stages could then be captured and added to a legacy archive for future use by those involved in the decision-making process.

4 Lancaster and Morecambe Case Study

Most major towns and cities across Britain are undergoing regeneration. The decline of the manufacturing industries and its related economy across the United Kingdom has led to widespread neglect of large inner-city area's where these industries once thrived. Plans to re-invigorate these once vibrant inner city areas combined with general plans for improvement of all major towns and cities are being drawn up by Government and Government agencies. Millions of pounds of public investment will be used in an effort to help stimulate physical, social and economic revitalisation and encourage private investment into these areas.

Although the larger cities have seen vast sums of money given to them for regeneration, the smaller towns and cities across the UK which have also seen major physical, social and economic decline in the last 30-40 years have not been so lucky. They too need to be regenerated however do not have the kind of funding available to them that the larger cities such as Manchester and Sheffield have through government schemes/deals such as the single regeneration budget (SRB). Consequently they struggle to raise money for re-invigorating the most basic of important elements in their urban environments such as parks and open spaces for recreation.

This study investigates the process of sustainable urban design decision-making that has taken place in the smaller sea-side town of Morecambe in the North West of England (part of Lancaster and Morecambe District Council) and examines the appropriateness of the use of decision-tree analysis during this process in the future to enhance the management of and harnessing of the knowledge that has been shared around large groups of people involved in developing the Masterplan for regeneration and the successful implementation of detailed plans which has resulted from various fundraising activities and stimulation of interest in their cause for regeneration.

4.1 The West End of Morecambe

Morecambe is on the North West coast of Lancashire and lies 3 miles to the West of the city of Lancaster, the once vibrant economy in Morecambe centred on tourism and competed with the nearby town of Blackpool for visitor numbers. Many of the visitors stayed in the large boarding houses which have now become multi-tenure housing (HMo's) following a sharp decline in visitor numbers to the area during the 1980's (mainly due to the availability of cheap holidays abroad). This sea-side town is now in need of an injection of funding for revitalisation and reinvigoration in order to return it to its former glory.

Private developers and landlords who have been responsible for the change in occupancy have altered the whole feel of the area. Many of the tenants have social problems (drug addition, unemployment, prison records) and those who still own homes have seen a decline in property values and tourist numbers and a rise in cheap housing, social deprivation and crime (Interviewee, 1, 3,4,6,10,).

The West End Partnership was set up as part of the 'Winning Back the West End' project. It is a Local Strategic Partnership (LSP) made up of local and county councillors, council employees, members of the local community, representatives from the housing Corporation, Adactus Housing, English Partnerships and the North West Development Agency.

The vision for regeneration in the West End was defined in the Masterplan for the West End which has been compiled in close collaboration with the local community. Its aim is to 'create an exceptionally good place to live, work and play in, which is based on healthy living, appreciation of the unique setting, art-deco heritage and speciality food and drink provision' (Winning back the West End, 2006). The core area's of consideration are:

- Retaining the best existing properties and refurbishing some where necessary.
- Creating new choices for residents (new and existing).
- Remodelling some properties so that they are family friendly. This can be done by removing the back annex, bringing kitchens and bathrooms into the houses again and creating gardens.
- Demolishing the worst properties and re-building new contemporary, energy efficient, sustainable properties in new designs.
- Redeveloping the former Frontierland site and former bus depot site.
- Creation of a community park in the heart of the West End.
- Improving the streets and creating a pedestrian and cycle friendly route linking to the town centre.

This programme of major regeneration in the West-End of Morecambe in combination with the regeneration of the flagship Midland Hotel building and adjacent land by Urban Splash, is seen as the catalyst for improving the whole of Morecambe and raising awareness and funding for further development (interviewee 5). It was therefore decided by the Director of Regeneration at Lancaster City Council that it was important to understand the process of sustainable urban design in the area and the West End Partnership were keen to cooperate and open to exploring means of improving the decision-making that takes place.

The decision to use decision-trees analysis in the West End gardens arose in response to questions raised in the literature review conducted into urban design and the design process. Many of the papers, books and articles cited that discuss urban design and what it is are not straightforward, suggestions are made that there are many ways that what is currently done can be improved and that the decision-making process generates loss of information and knowledge that is not currently captured in any meaningful way for future use. However there is a lack of suggested solutions as to what can be done to improve the situation. Decision-Trees are complex and there are many ways that they can be used. Simple decision-trees can be drawn to show the decision-making that takes place during the urban design decision-making process to provide those involved in the decision-making process with a guide to where important decisions are made. This can then prompt capture of data/information at these key stages for future use.

5 Research Conducted

The initial meeting with the Director of Regeneration at Lancaster City Council, the Director of Regeneration of the West End Partnership in Morecambe and the Culture and Pride Steering Group Chair identified the West End of Morecambe as being the area for research and investigation into the sustainable urban design decision-making process and examination of how related knowledge is managed.

A scoping paper was presented for approval to the Director of the West End Partnership and the Director of Regeneration at Lancaster city council which detailed the proposed research. This was approved. The Masterplan for the regeneration of the West End of Morecambe had been drawn up and the local community through the local partnership were already working closely to move forward implementation of the plans for the regeneration of the area.

The West End is considered the worst part of the district and at the end of 2007 work had already begun on implementation of their initial key projects, some of which were nearing completion.

The West End Partnership holds regular monthly meetings. It was at this meeting In June 2007 that the proposed research was introduced and scoping paper delivered to the West End Partnership (WEP). The introduction included an explanation of decision tree analysis and an overview of the work conducted by Boyko, 2005 into Sustainability, urban design and the urban design decision making-process. Everyone agreed that comparing the Boyko model against the reality of what goes on in the West End of Morecambe could potentially be very useful to the West-End Partnership (WEP).

The sample of interviewees was decided upon by the Director of Regeneration in the West-End, the people chosen were 'a representative sample of the range of people involved in the work of the WEP' (Matthews, 2007). Interviews were subsequently arranged with members of the WEP, the list of interviewees included members of the local community, local and county councillors, private landlords and officers from the local partnership working for the Lancaster City Council. The interviews were structured and held in order to extract details of where decisions were made and by who during the regeneration process in the West End of Morecambe. This meant in-depth discussion on each persons' involvement and responsibility in the decision-making process for various projects and discussion of the process as they saw it of sustainable urban design decision-making. Detailed content analysis showed an overview of where decisions are made and by who in respect of the regeneration of the west end of Morecambe. This enabled the decision-tree for the West End gardens to be drawn and verified by the WEP as being a true representation of the decision-making process that took place. The decision-tree was populated with assistance to of the interviewees who were involved in the regeneration of the West End gardens.

Two further informal unstructured interviews were conducted, one with a local resident in the west end gardens and one with a customer in the café on Balmoral Road. These two interviews were aimed at establishing the view that members of the local community have of the work that has been conducted to date by the local regeneration company.

A total of 25 interviews were conducted.

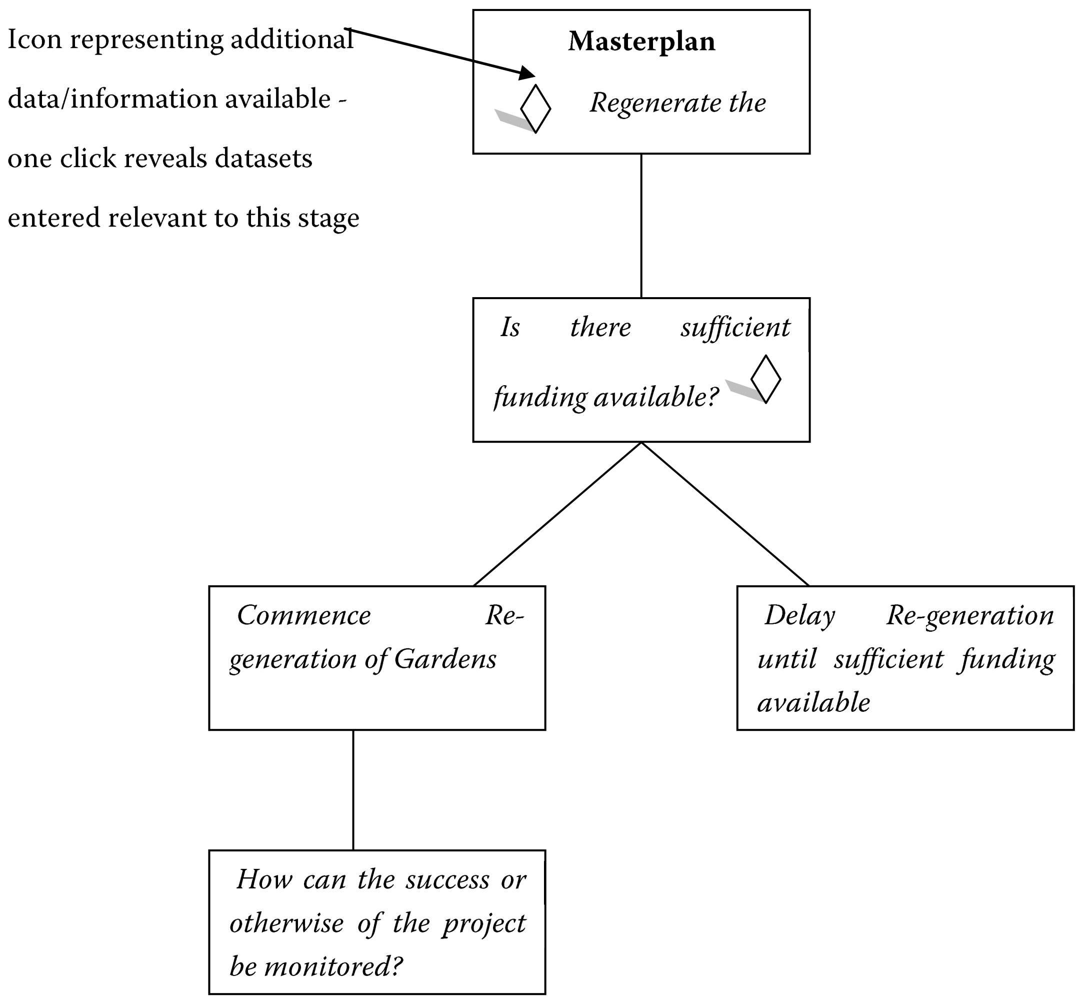
6 Findings

The generic urban design decision-making process defined by Boyko, 2005 in Appendix A provides an overview of the many functions that are performed during the process of sustainable urban design decision-making. This model is useful in that it clearly identifies the process as being iterative and complex involving many stakeholders with a range of inputs which require consideration in order for acceptable outcomes to be achieved. However, individual organisations and regeneration companies have their own methods of working and therefore the model, although useful as a guide to activities, is not a blue-print for what happens everywhere. In the West End of Morecambe many differences were identified in the way that things are done and managed. The research has also shown that the decision-making that takes place is unique to the West End because of the way in which they work.

The decision tree drawn for the West-End gardens below shows the decision-making that has taken place during the regeneration of the West End gardens. Although appearing to be linear the process was not and many of the stages were re-visited - some several times. Behind each step there were a range of decisions that took place, some strategic decisions or high level/senior decisions which have long term impact such as the decision to have a café and toilets, some tactical decisions such as the decision to have sustainable planting throughout the gardens and other decisions which were operational/day to day decisions such as the decision-making that led to the choice of paint colour for the fencing. All this data/information can be held by the decision-tree at each stage for future use as and when required. In essence, the decision-tree shows that although this is a relatively small project for the Local Strategic Partnership in the West End of Morecambe the decision-making that has taken place was complex and involved a great deal of decision-making which has necessitated information/knowledge sharing amongst those involved in order to successfully complete the project.

Decision-Tree for the Regeneration of

the West-End Gardens



Although records are kept for the projects in the West End much of the information/data necessary for creation of decision-trees is not currently captured. The research conducted to date is incomplete. Two further case-studies will be conducted into the use of decision-tree analysis on schemes in the West-End - The Exemplar Scheme and Yorkshire Street. The findings of which will supplement the findings from this research.

The decision-tree created for the West Gardens provides those involved with regeneration now and those who might become involved in the future with an archive of information showing the decision-making that took place and who was involved.

7 Conclusion

Urban design and the process of making sustainable urban design decisions is complex. Those who have been involved in work in this area recognise the need to manage more efficiently and effectively the knowledge shared amongst the professionals with whom they share responsibility for decision-making. Although there is a need to find new ways of improving the way in which data/information and knowledge is captured stored and shared there are few suggested solutions to what is a widespread problem.

This study has shown that decision-Trees and decision-tree analysis can be a very useful tool to help capable of improving the management, storage and sharing of knowledge and information/data. Decision-trees are able to map the decision-making that takes place and more importantly capture the detailed reasoning behind the decisions for future use. This is an important feature that will allow decision-makers to query past decisions and apply the knowledge learned to help inform decision-making on current and future issues.

Money is scarce in the West End and Morecambe in general suffers from a lack of funding. The team are constantly actively looking at ways to save money and make money. Anything that can be done which is inexpensive that will save them money in the future is of value to them and worth consideration. The Team in the West End of Morecambe therefore believe strongly that having decision-tree software available to them to use in their daily work could be a great advantage and could improve decision-making and knowledge/information retention and potentially save them a great deal of money.

8 References

Aitkenhead, M.J (2007) A co-evolving Decision-Tree Classification Method in Journal of Expert Systems with Classifications Vol.34, No., pp. 18-25

Bahl, H,C and Hunt, R.G (1984) Decision-Making Theory and Decision-Support Systems DATABAS Vol.15, No.4, pp. 10-14

Barnett, J (1992) "An Introduction to Urban Design" New York, Harper and Row

Bentham, J (1924/1987) An Introduction to the Principles of Morals and Legislation in J.S.Mill and J.Bentham Utilitarianism and other Essays: Harmandsworth, Penguin

Boitsidis, A.J et al. (2006) A Decision Support System for Identifying the Habitat Quality and

Rehabilitation Potential of Urban Rivers in Water and Environment Journal Vol.20, No.3, pp.130-140

Bouzida, Y and Cuppens, F (2006) Neural Networks vs Decision-Trees for Intrusion Detection

IEEE/IST workshop on Monitoring, Attack Detection and Mitigation Tuebingen Germany

Boyko, C.T., Cooper, R and Davey, C.L (2005) Sustainability and the Urban Design Process

Engineering Sustainability, Proceedings of the Institutions of Civil Engineers, Sustainable Urban

Environments: Part 2, Volume 158, Issue ES3, 119-125

Brady, T; Rush, H; Hobday, M; Davies, A; Probert, D and Banerjee, S (1997) Tools for Technology Management Technovation, Vol.17, No. 8, pp.417-426

Buchanan, L and O'Connell, A (2006) A Brief History of Decision-Making in Harvard Business Review, January 2006 pp. 32-41

Byrd, E. T and Gustke, L (2007) Using Decision-Trees to Identify Tourism Stakeholders: The Case of

Two Eastern North Carolina Counties in Journal of Tourism and Hospitality Research Vol.7, No.3/4,

pp.176-193

Canadian Institute of Planners (CIP) (2000), The Urban Design Process available at

www.cip-icu.ca/English/aboutplan/ud_proce.htm Accessed 5th June 2007

Carmona, M; De Magalhaes, C and Edwards, M (2002) Stakeholder Views on Value and Urban Design

in Journal of Urban Design Volume 7, Issue 2, 145-169

Cohen, M.D; March, J.G and Olsen, J.P (1972) A Garbage Can Model of Organisational Choice in Administrative Science Quarterly, Vol. 17 No.1 pp.1-25

Courtney, J.F (2001) Decision-Making and Knowledge Management in Inquiring Organisations in

Journal of Decision-Support Systems Vol.31, No. 1, pp.17-38

Cuthbert, A (2004) Description = Explanation: Theory in Urban Design? Economic and Social Research

Council: Seminar on Urban Design, London, April 2004

Cyert, R.M and March, J.G (1963) A Behavioural Theory of the Firm Englewood Cliffs (NJ) Prentice Hall

DeMichelis, G (1996) Co-ordination with Cooperative Processes In P.Humphrey, L.Bannon, A.McCosh, P Migliarese and J.Cl. Pomerol (Eds.), in Implementing Systems for Support Management Systems pp.108-123 London Chapman and Hall

Department of the Environment (DoE) (1995) Quality in Town and Country: Urban Design Campaign,

London, Department of the Environment

Design Council (2006) Double Diamond Design Process Design Council and available from

www.designcouncil.org.uk

Drechsler, M and Burgman, M.A (2004) Combining Population Viability Analysis with Decision

Analysis Biodiversity and Conservation Vol. 13, pp.115-139

English Partnerships Urban Design: Key Principles of Urban Design from the Urban Design

Compendium - available at http://www.englishpartnerships.co.uk/urbandesign.htm Accessed - 20th

January 2007

Faludi, A (1973) Planning Theory Oxford, Pergamon Press

Filip, F.G (2007) Decision Support and Control for Large-Scale Complex Systems in Annual Reviews in

Control 32 pp. 61-70

Gorry, G.A and Scott-Morton, M.S (1971) A Framework for Management Information Systems in Sloan Management Review Vol. 13, No.1

Greed, C (1995) "Implementing Town Planning: The Role of Town Planning in the Development Process" Harlow, Essex, Longman

Greed, C (1996) "Introducing Town Planning" (2nd Ed.), Harlow, Essex, Longman

Greed, C and Roberts, M (1998) "Introducing Urban Design: Interventions and Responses" London, Longman

Huang, L.T; Gromiha, M.M and Ho, S-Y (2007) Sequence Analysis and Rule Development of Predicting Protein Stability Change Upon Mutation Using Decision Tree Model in Journal of Molecular Modelling Vol.13, No.8, pp.879-890

Huber, P (1981) Robust Statistics New York, Wiley

Jacobs, J (1961) "The Death and Life of Great American Cities" New York, Random House

Kelly, C (2007) Managing the Relationship between Knowledge and Power in Organisations Aslib Proceedings Vol.59, No.2, pp.125-138

Leavitt, H.J (1988) Managerial Psychology University of Chicago Press

Little, R.J.A (2002) Statistical Analysis with Missing Data 2nd.ed, Hoboken, N.J Wiley

Lucy, T (1997) Management Information Systems (8th Ed.) Gosport, Hampshire, Ashford Colour Press

Lynch, K (1981) "Good City Form" Cambridge, MA, MIT Press

Lynch, K (1984) The Immature Arts of City Design in Places Volume 1, Issue 3, 10-21

McGlynn, S and Murrain, P (1994) The Politics of Urban Design in Planning Practice and Research Volume 9, Issue 3,

Miller, S.F (1995) "Design Process: A Primer for Architectural and Interior Designers" London, Chapman and Hall

Mintzberg, H (1979) The Structuring of Organisations: A Synthesis of the Research Englewood Cliffs (NJ), Prentice Hall

Mitroff, I.I and Linstone, H.A (1993) The Unbounded Mind: Breaking the Chains of Traditional

Business Thinking New York Oxford University Press

New Zealand Ministry for the Environment (2004) on line available at

http://www.mfe.govt.nz/issues/urban/design-protocol/index.html

Pfeffer, J (1981) Power in Organisations Marshfield (Ma) Pitman Publishing

Prusak, L (2001) Where did Knowledge Management Come From IBM Systems Journal Vol.40 No.4

Punter, J (1990) The Ten Commandments of Architectural and Urban Design, The Planner, Volume 76,

Issue 39, 10-14

Punter, J.V and Carmona, M (1996) Design Policies in Local Plans:recommendations for good practice

Town Planning Review, Issue 68, 165-193

Puy, N (2008) Integrated Assessment of Forest Bio-energy Systems in Mediterranean basin areas: The

Case of Catalonia and the Use of Participatory IA-focus Groups in Renewable and Sustainable Energy

Reviews Vol.12, no.5, pp. 1451-1464

Reekie, F (1972) "Design in the Built Environment" London, Edwards Arnold (Publishers) Ltd

Reiss, G (1995) Project Management Demystified London E & FN Spon

Roberts, M and Greed, C (2001) "Approaching Urban Design - The Design Process" Harlow, Longman

Rose, R (1974) The Management of Urban Change in Britain and Germany in Conference of Committee

on Political Sociology, London (1st-5th April 1973)

Rowland, J (1995) The Urban Design Process Urban Design Quarterly, Vol. 56

Rowley, A (1994) Definitions of Urban Design: The Nature and Concerns of Urban Design in Planning

Practice and Research, Volume 9, Issue 3, 179-198

Schurch, T.W (1999) Reconsidering Urban Design: Thoughts about its Definition and Status as a Field

or Profession in Journal of Urban Design, Volume 4. Issue 1

Shirvani, H (1985) The Urban Design Process New York, Van Nostrand Reinhold

Simon, H.A (1996) The Sciences of the Artificial 3rd Ed. MIT Press

Sowell, T (1980) "Knowledge and Decision" New York, Basic Books

Stewart, T.A (1991) Brainpower Fortune Vol.123 No.11, pp 145-146

Stoeglehner, G and Narodoslawsky, M (2007) Implementing ecological foot printing in decision-making

processes in Journal of Land use Policy Vol. 25, No.3, pp.421-431

Sunjoo, L (2007)

Tiesdell, S (2002) The New Urbanism and English Residential Guidance: A Review Journal of Urban Design Vol. 7 No.4, pp.353-376

Toon, J (1988) Urban Planning and Urban Design Ekistics, 55 (328-330) 95-100

Vancouver City Council available at www.vancouver.ca/commsvis/planning/udp/udp.html accessed 20/11/2008

Varkii, G. R (1997) A Procedural Explanation for Contemporary Urban Design in Journal of Urban

Design, Volume.2, Issue 2

Wu, S.M; Chao Yu, Y.M; Yang, C.F and Che, H I (2005) Decision-Making Tree for Women

Considering Hysterectomy Journal of Advanced Nursing Vol.51, No.4, pp.361-368

Zachariadis, T (2005) Assessing Policies Towards Sustainable Transport in Europe: an Integrated Model

in Energy Policy 33 pp.1509 - 1525

Appendices

Appendix A

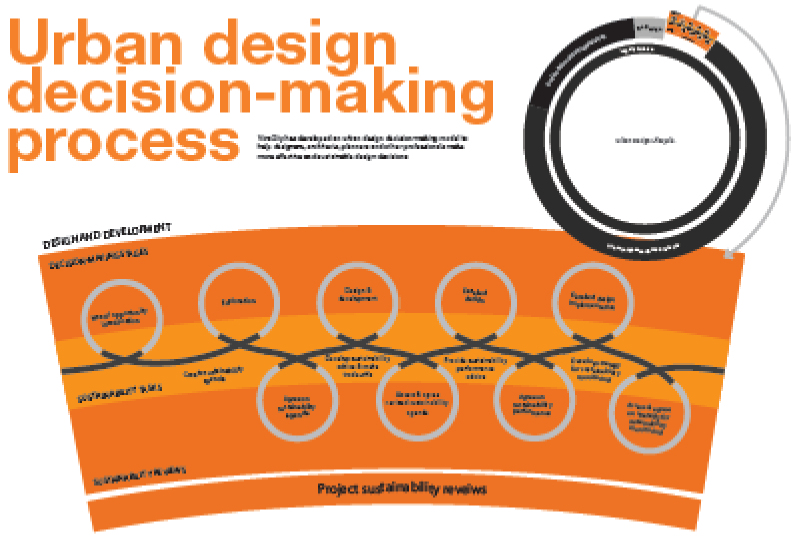


Fig. 1 The urban design decision-making process - Boyko et al, 2005

Heading 1 - Bold Warnock Pro Size 16

8.1 Heading 2 - Bold Warnock Pro Size 13

8.1.1 Heading 3 - Bold Warnock Pro Size 11

8.2 General information on styles of the template

The paper must be submitted in A4 paper. The length of the paper should be limited to four to six thousand words.

This template will allow you use up to three levels of headings, 'Heading 1', 'Heading 2' and 'Heading 3' respectively. Each heading will be numbered automatically. Headings should not be entered in upper-case, but capitalised like regular sentences.

Normal body paragraphs are to be in the Word style named 'Normal', which is 11 point Warnock Pro with full justification. Please do not add extra blank lines between headings and paragraphs or indentation before a paragraph, as appropriate spacing or indentation defined by the styles of the template will be automatically generated.

Please note that all references to style names refer to styles in the supplied template document. The following are the details of styles used in the template:

8.3 Paper margins

- Left - 1.5" (3.81cm)
- Right - 1.5" (3.81cm)
- Top - 1.0" (2.54cm)
- Bottom - 1.0" (2.54cm)

8.4 Header and footer

Both the header and footer areas must be left blank and author names must not be included in the paper itself in order to facilitate the double-blind review process.

8.5 Page number

Please do not number the pages in your Word document, as pages will be numbered automatically after submission.

8.6 Tables

Tables should be kept as simple as possible. Make sure that they are referred to from the text, for example: (see Table 1). Table(s) or figure(s) may not appear earlier in the text than the explicit reference to it does (for example, 'See Table 2'.). Do not use the words 'above' or 'below' to refer to a table or a figure. Please avoid grey shading and 3D effects from all tables. They may not photocopy or print well and frequently obscure the message. Table captions should be in the 'TableCaption' style and appear above the table in question.

Table 1: Key styles of the template

Style Name	**Example**	**Description**
Heading 1	**9 Heading 1**	Warnock Pro Bold, 16pt

Heading 2	**9.1 Heading 2**	Warnock Pro Bold, 13pt
Heading 3	**9.1.1 Heading 3**	Warnock Pro Bold, 11pt
List Bullet	• List item 1 • List item 2	Warnock Pro 11pt, 0.63cm indent
List	1. List item 1 2. List item 2	Warnock Pro 11pt, 0.63cm indent
Table Caption	Table 1: key styles of template	Warnock Pro Bold 11pt, centred
Table Heading	**Table heading**	Warnock Pro Bold 11pt
Figure Caption	*Figure 1: SUE-MoT consortium partners.*	Warnock Pro Italic 11pt, centred
Quote	*Quote*	Warnock Pro Italic 11pt, Left and right indentation: 1.2cm
References	Neale, R H, Price, A D and Sher, W D (1993) "Prefabricated Modules in Construction". Berks: Chartered Institute of Building.	Warnock Pro 9pt, Hanging: 1.27cm
Appendix Heading	**Appendix heading**	Warnock Pro Bold 16pt
Subscript	Subscript	Warnock Pro 11pt
Superscript	Superscript	Warnock Pro 11pt

10 Figures

Figures should be kept as simple as possible. Figures should be used where relevant, but do not use them unnecessarily. Make sure that they are referred to from the text and that they are not too complicated or large. A figure caption ("SM2-FigureCaption" style) should be inserted immediately below your figure. If your work relies on the presentation of complex graphics, then the paper can make a point with an extract from a larger graphic. Colour may be lost in the reproduction of the proceedings and cause images to occupy more disk space than monochrome. Do not include screen shots of computer displays. It is better to render the relevant information into a simpler graphic or chart.

Figure 2: SUE-MoT consortium partners.

10.1 Footnotes

Footnotes should be avoided.

10.2 Acknowledgements

Acknowledgements should follow the references. Please do not start a new page.

11 References

References should appear at the end of your paper but do not start a new page. References should be ordered alphabetically by the first author's surname. If the author's name is not part of the phrasing of the sentence when referring to a reference, then it should be in brackets with the year (Hughes 2002) whereas if you are using the author's name as part of the text of the sentence, then only the year is in brackets (2000). When citing author and year together, there is no need to separate them with a comma. The precise location within the source material can be given as page number(s) after a colon (Hughes 2002: 34-36). Some example references of different types are shown below.

11.1 Chapter of a book

Flint, F O (1984) Advances in light microscopy of foods. In: G.G. Birch and K.J. Parker, (eds.) “Control of food quality and food analysis”. London: Elsevier Applied Science Publishers.

11.2 Book

Neale, R H, Price, A D and Sher, W D (1993) “Prefabricated Modules in Construction”. Berks: Chartered Institute of Building.

11.3 Thesis

Paranagamage, IPDH (2006) "Changing boundaries and meanings of the Home", Unpublished PhD Thesis, The Bartlett School of Architecture and planning, University College London, London.

11.4 Conference paper

Thomson, C S, El-Haram, M A, Hardcastle, C and Horner, R M W (2008) Developing an urban sustainability assessment protocol reflecting the project lifecycle. In: Dainty, A (Ed) Procs 24th Annual ARCOM Conference, 1-3 September 2008, Cardiff, UK, Association of Researchers in Construction Management, 1155-1164.

11.5 Journal

Walton, J S, El-Haram, M, Castillo, N H, Horner, R M W, Price, A D F and Hardcastle, C (2005) Integrated Assessment of Urban Sustainability, ‘Engineering Sustainability’, volume 3, issue 7, 57-65.

12 Appendices

Appendices should follow the references and do not start a new page. Any appendices should be titled using the style ‘Appendix Heading'. If your paper has one appendix, please name it ‘Appendix’, otherwise name them as ‘Appendix A', ‘Appendix B' and ‘Appendix C’, etc.

How to design a city in five easy steps: exploring VivaCity2020's process and tools for urban design decision-making

Prof. Rachel Cooper, Dr Christopher Boyko

Lancaster University, UK

Urban designers and planners are increasingly being asked to create and maintain communities that are more socially, economically and environmentally sustainable. Governmental and non-governmental organisations, such as the Department for Communities and Local Government (formerly Office of the Deputy Prime Minister), the Department of Environment, Food and Rural Affairs (formerly comprised of portfolios from the Department for Environment, Transport and the Regions) and the Commission for Architecture and the Built Environment, have published numerous reports and policy documents outlining the relationship between sustainability and urban design. These reports and documents provide information and practical and aspirational guidance about the value of good design and the delivery of sustainable communities. To achieve the high expectations set out by Government and affiliated organisations, some decision-makers have been exploring how buildings and open spaces 'come to be', that is, how they develop from an idea to finished project and beyond. Knowing who is making decisions, what tools they are using to make decisions and whether or not they are considering sustainability can help those involved in the process of urban design to understand the complexities and tradeoffs surrounding when and how to incorporate sustainability into projects. This paper begins by discussing our current state of understanding about the urban design process as reviewed in the relevant literature. To do this, the fields of architecture, business, design, engineering, manufacturing and planning were surveyed to understand how processes are depicted, how they function and what similarities and differences exist between those processes and a plausible process for urban design. Research conducted as part of the VivaCity2020 project is presented next, highlighting case studies from three major UK cities–London, Manchester and Sheffield–and what we have learned from understanding the urban design process in-practice. The above processes are then compared, illustrating that sustainability and the tools used to make decisions are not often consistently considered by decision-makers in the process. To this end, a revised urban design process was created and validated by experts in design, planning, regeneration and sustainability that attempts to consider sustainability at each stage of the process. Along with the process is a suite of tools, developed during the VivaCity2020 project, that can be used when making decisions about a broad range of sustainability issues, including mixed-use, land-use diversity, environmental quality, housing choices, and public conveniences. A series of tools and the process, consisting of five stages, tasks and reviews, will be explained, all of which decision-makers can utilise and follow to create more sustainable urban design projects.

Keywords: decision support, design process, tools, urban design, urban sustainability

Introduction

Conventional wisdom states that nothing worth doing comes easy. This is true for many things, including designing cities. A raft of guidance from Government and non-governmental organisations tells us what we *should* do to create sustainable communities. Local authority planners attempt to enact this guidance while wrestling with the everyday realities of people and places in their area. Private sector decision-makers—architects, developers, landowners, investors—have their own bottom lines to worry about (e.g., making money, acquiring sites for development, designing great buildings and spaces). Residents want neighbourhoods that they like, feel attached to and are safe for their families. In short, the process for designing places is complex and fraught with endless tradeoffs and negotiations between the multitude of stakeholders over the short-, medium- and long-term.

Does this mean, then, that cities cannot be designed in five easy steps? Probably not, but knowing more about this process—what are the stages and actions involved in designing cities, who makes decisions, what tools are used to make decisions and what issues are discussed—can help to shed light on the complexity of designing cities and, in particular, more sustainable urban design projects within these cities. The EPSRC SUE project, *VivaCity2020*, explored the process for urban design projects in the wider context of sustainability over 5 years, conducting an extensive literature review and case studies in London, Sheffield and Manchester. The result was a baseline process taken from the literature, three case study processes of urban design decision-making in-practice and a revised generic process that incorporated valuable information and lessons learned from the baseline and case study processes (i.e., sustainability and decision-making tools were not applied consistently throughout the lifetime of urban design projects). This paper briefly reviews the urban design literature and outlines the baseline process. Case studies are discussed next, followed by a presentation of the revised urban design process with tools that decision-makers can use to make more sustainable urban design decisions.

Urban Design and the Urban Design Process

Urban design is a multidimensional concept that highlights the transformative nature of urban environments (Barnett, 1982; Gosling, 2000; Rowley, 1994). Such transformation is perceived mostly in physical terms (e.g., re-positioning roads, pavements and open spaces to make a neighbourhood more legible); however, people have an important role to play in urban design. Through their evolving aesthetic, emotional, functional, psychological and social wants and needs, people act as drivers for urban design, shaping how urban environments look, feel and are used. The design of urban environments also has the capacity to shape how people behave, feel and think in such spaces. Thus, urban design is about transformation as well as reacting to, ongoing interaction with and being influenced by the urban environment.

From this, a definition of urban design is presented: urban design refers to the *dynamic art* and *process* of designing, creating, making and managing spaces and places for people (adapted from CABE & DETR, 2000; Rowley, 1994; emphasis added). The notions of urban design as both a dynamic art and a process are key to this definition.

‘Dynamic art’ stresses creativity as well as context. While urban design may be comprised of a relatively generic set of principles, people, such as architects and artists, may re-interpret these principles into innovative ideas that best suit the context in which they are working (see Rogers & Power, 2000, for a description of context). Increasingly, the community is becoming more involved in shaping the urban design of an area, in line with the UK Government’s remit for creating more sustainable communities (CLG, 2006; ODPM, 2002, 2003, 2004, 2005a, 2005b, 2006).

‘Process’ stresses the following of a method, procedure or series of actions that lead to the accomplishment of a result (Atkin, Borgbrant, & Josephson, 2003; OED, 2005). This method, procedure or series of actions is often complex, iterative and non-linear (Rowley, 1994), involving many different people and issues throughout the lifetime of an urban design project. Illustrating a generic, conceptual guide adds value to the individual parts and people in the process; thus, the resulting whole becomes greater than the sum of its parts (Carmona & Tiesdell, 2007).

A generic process for urban design allows the ‘dynamic art’ to be articulated. Such a process can demonstrate potential creativity in urban design projects by giving decision-makers the opportunity to be innovative amidst a multitude of constraints (e.g., site, financial). A generic process also is capable of incorporating context-specific issues into the set of specific stages and actions that decision-makers can follow.

A review of the relevant literature highlighted that a precise process for urban design did not exist. Thus, a generic process was created from an amalgamation of existing design processes to begin to understand the complexity of urban design decision-making. In-practice urban design processes could then be compared to the generic process to understand whether the conceptual model fits with what occurs in the ‘real world’.

From a consultation of design processes in architecture (RIBA, 1999), business (Smith & Jackson, 2000), manufacturing, construction, engineering (Austin et al., 2001; Cooper et al., 2005; Woodhead, 2000), non-governmental organisations (English Partnerships, 2000; Heritage Lottery Fund, 2000), planning (Bressi, 1995; Nelessen, 1994; Okubo, 2000; Roberts, 2003; Wates, 1996, 1998) and ‘urban design’ (Biddulph, 1997; Canadian Institute of Planners, 2000; Rowland, 1995; see also Macmillan et al., 2002), the following generic process was created with four stages and four transition stages:

Stage 1: “Creating teams, appraising the situation and forming goals.” This is when decision-makers begin thinking about an urban design project. During this stage, teams are formed, the project site and its context are assessed through a variety of ways (e.g., site survey, valuation of surrounding sites), project objectives are written, stakeholders are identified of the project, funding is sought and timescales are drafted.

Stage 2: “Designing and developing.” Here, decision-makers are designing different options for the project. This action will be based on a design brief developed by the team as well as an evaluation and testing of ideas in the brief and, ideally, stakeholder feedback.

Stage 3: “Evaluating, selecting and creating a plan.” The urban design options are assessed in light of the objectives in Stage 1 and decision-makers will chose an option. This option will be evaluated further, stakeholders will be consulted on the option and a plan including timescale will be devised.

Stage 4: “Implementing, monitoring and following up.” The decision-makers implement their selected option via the construction process. Once built, the urban design project will be monitored and a group (e.g., management company) will be set up to manage the project.

In between the stage are transition stages—“Continuing to understand the context”, “Continuing to think about alternatives”, “Re-creating a plan” and “Continuing the process”—that act as “soft gates” for decision-makers to re-evaluate their past actions and plan for the next stage (Kagioglou et al., 1998). The transition stages also support the idea that the process is iterative, as decision-makers may use the transition stages to amend actions from a previous stage before moving on to the next stage.

The next section highlights three case studies, undertaken for the *VivaCity2020* project. The case studies represent ‘real world’ examples of urban design processes from different urban design projects in the United Kingdom.

Urban Design Process Case Studies

Urban design projects within London, Sheffield and Manchester were chosen because of their scale and type of development. A small- (i.e., urban block), medium- (i.e., city centre neighbourhood) and large-scale (i.e., area comprising seven neighbourhood boroughs) development was selected, each with different objectives: infill, repair and recovery and regeneration, respectively. The processes also covered different timescales because each project had a different starting and ending point.

City/site	Scale of development	Type of development	Process timescale
Clerkenwell, London (Brewhouse Yard)	Urban block	Infill, mixed-use, contemporary and listed buildings	10 years
Sheffield city centre (Devonshire Quarter)	Neighbourhood/quarter	Repair and recovery, mixed-use (leisure, office, residential, retail)	25 years
Manchester/Salford (Central Salford)	7,200 hectares, seven boroughs	Urban regeneration	3 years

Urban design processes were mapped for each project, based on the gathering of multiple sources of information (e.g. archival materials, interviews, questionnaires, observations) from a range of decision-makers and stakeholders (e.g., academics, architects, developers, government, residents). Each process told a story about urban design decisions and who made those decisions; tools used in decision-making; who the stakeholders were, and; what were the major issues involved in the urban development site, including sustainability.

Case Study Findings

Each of the processes was mapped using timescales to illustrate discrete stages and actions or decision points (see Figures 1, 2 and 3). Researchers chose to use timescales because this method of understanding decisions had been utilised in previous research (see Cooper et al., 2005). Moreover, timescales permitted researchers the ability to follow the progress on an urban design project, from its early stages to its completion and beyond or, as seen in the Manchester case study, up to its current day status. Knowing chronologically what happened enabled a story to be told and helped to better identify decision points as and when they occurred (i.e., decisions could be more easily identified—using the generic urban design process, which is based on an amalgamation of established decision-making processes, as a guide—through knowledge of what occurred immediately before, including who was involved in previous decision-making and what tools they used to make those decisions). In the London and Manchester case studies, the actions and stages related to some of the actions and stages in the generic urban design process (Boyko et al., 2005, 2006). In the Sheffield case study, the process took the form of five key decisions, rather than discrete stages and actions. Because several key decision-makers contributed to the development of the neighbourhood, understanding how they contributed to the overall area was important in illustrating the process. With more time, process maps could have been developed for each of the five key decisions as stand-alone processes.

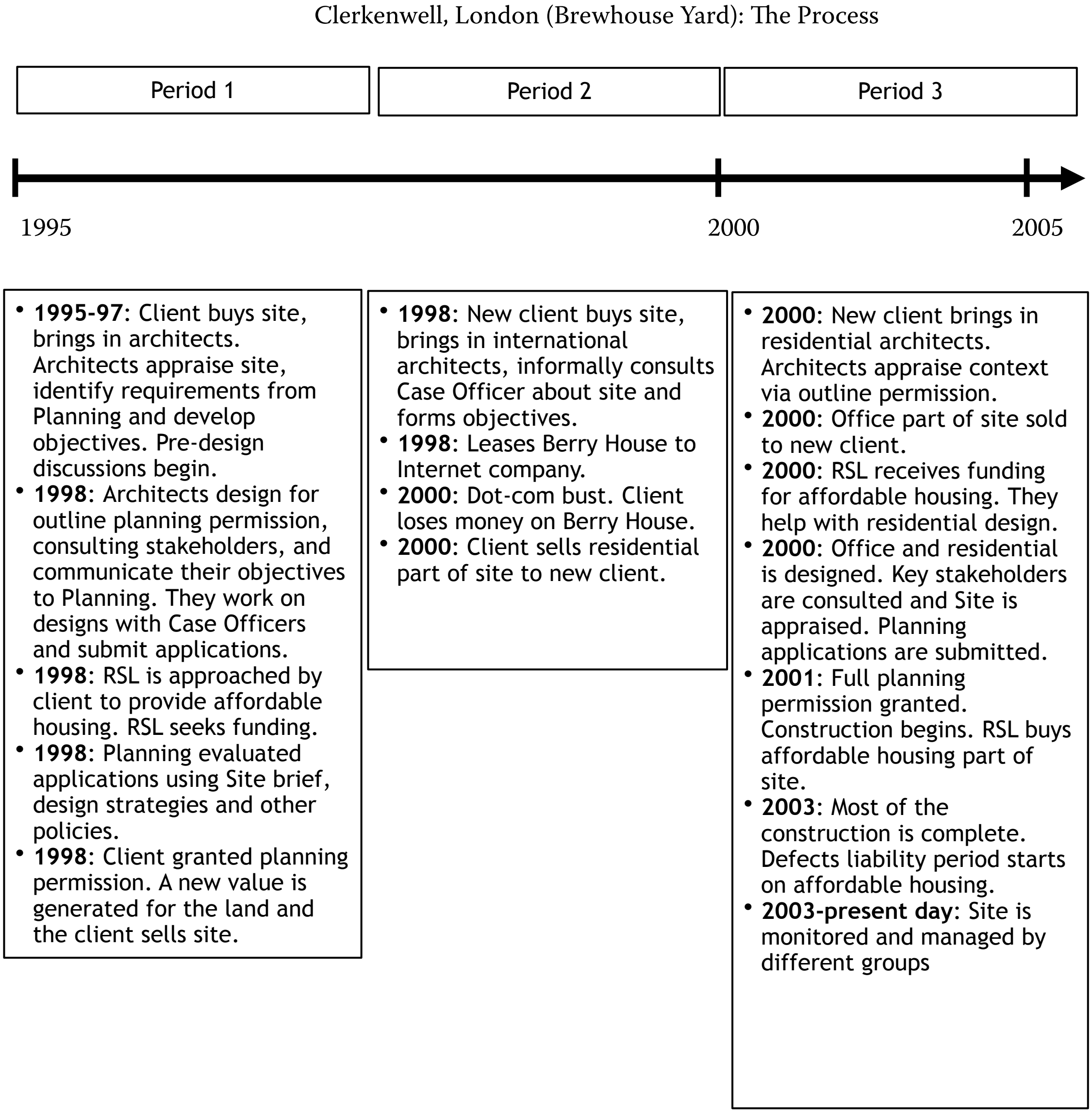


Figure 1. The urban design process for the London case study. Source: *VivaCity2020.*

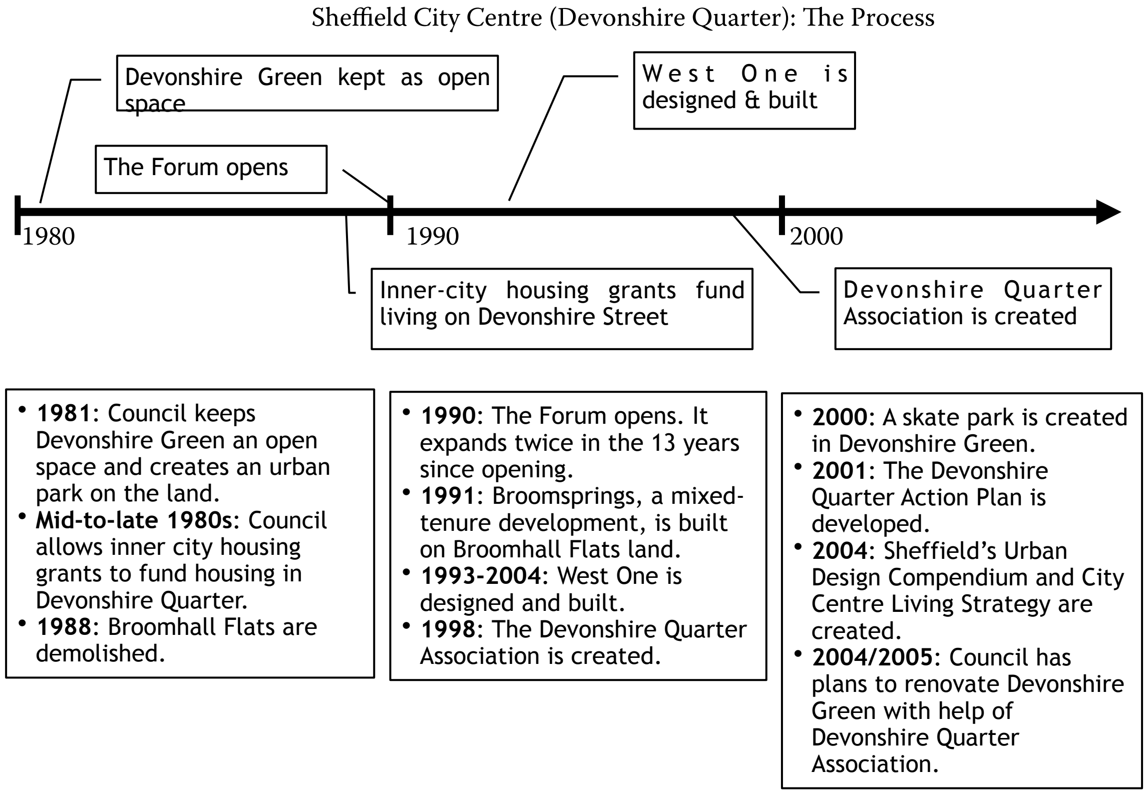


Figure 2. The urban design process for the Sheffield case study. Source: *VivaCity2020.*

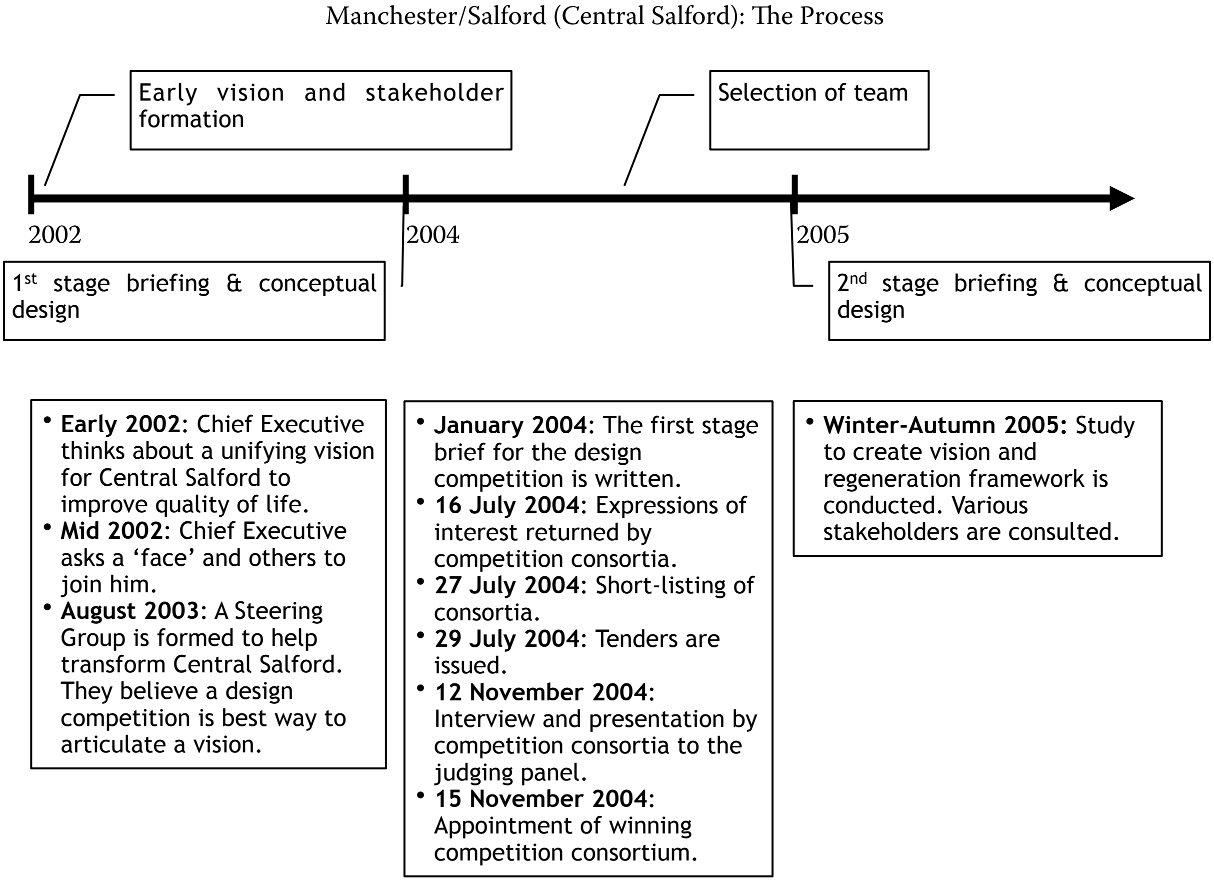


Figure 3. The urban design process for the Manchester case study. Source: *VivaCity2020.*

Looking across the three case studies, relevant findings surfaced about the urban design processes, sustainability and tools. Each of these issues will be discussed in turn.

The Process

All three case studies highlighted the lack of an explicit urban design process being followed (e.g., written down, visual, tabular). Rather, decision-makers employed an *ad hoc* process, particularly in London and Sheffield, shaped by past experiences, knowledge, policy, private sector needs and the public sector planning process. These *ad hoc* processes were shared implicitly within individual organisations (e.g., architecture firm), but not necessarily between organisations (e.g., local authority and developer).

In the Manchester case study, a process for forming an urban regeneration company (URC) was observed. The team involved with the URC used guidance from English Partnerships, additional guidance documents and past experiences from established URCs to help consider different strategies. The URC team *was* following a process (i.e., for establishing a quasi-governmental body to consider urban regeneration), albeit not a process for more sustainable urban design in the regeneration area.

Tools

Decision-makers employed a variety of tools in the three case studies. These included general government guidance, interpersonal skills, personality traits, planning documents and temporal/structural issues. Rarely mentioned was computer-based support. This could be because the interviewees often had technical help to assist them when needed. Nonetheless, the increasing ubiquity of such tools indicates that they will continue to play a critical role in decision-making.

In London, decision-making tools were a mix of both human- and policy and planning-centred. Public sector planners mentioned that the right team, comprised of good-quality planners to achieve a local authority's goals, was fundamental. Team members also needed to have good brief-writing and design strategy skills, know suitable government policy, be conversant with the historical area and planning context and hold pre-planning application meetings to negotiate planning-related issues and develop a good, long-term working relationship with applicants. Private sector decision-makers said that holding internal design review meetings were key, particularly for architects who wanted constructive feedback from colleagues before showing client teams any designs.

In Sheffield, the local authority mainly referenced government policies and programmes when making decisions. They also read academic journals and trade magazines about various issues (e.g., city centre housing) and had an intimate knowledge of the economic climate in the city, which was helpful when making decisions about new development opportunities. Private sector decision-makers used their knowledge and prior experiences in Sheffield to find the best development opportunities. This often took the form of relying on "gut feelings," rather than using common research studies to make decisions. Nonetheless, they always tried to have a good working relationship with public sector planners.

In Manchester, many of the local authority's decision-making tools were people- and characteristics-based. This is likely because the process was just beginning; thus, reflection was needed to think about leadership, the team, goals and value systems. Central Salford had a visionary leader who had strong conviction and fervour to take forth an urban regeneration vision. The leader also knew that he had to surround himself with the "right" team, so he first hired a media-savvy person who was passionate about Central Salford. Together, they employed a team with experience and knowledge in academia, brief writing, business, government, planning, regeneration, and the city, itself. They all shared a similar value system (i.e., increasing quality of life).

Sustainability

The three case studies demonstrated that sustainability was explicitly considered in decision-making. However, it was considered by different decision-makers, at different times and at different levels of detail.

Decision-makers

Most of the decision-makers who made decisions about sustainability were in local authority planning departments. They were responsible for examining the robustness of the planning applications within context. Such assessments included a range of finegrained decisions about building details (e.g., the style of pointing used between bricks) and more strategic design decisions (e.g., the legibility of a site in a built-up borough), all of which impacted on the sustainability of the urban design projects.

Private sector developers and architects made sustainability decisions, often in consultation with clients, landowners, financiers and insurance actors. The level of decision was mostly at the building-level (e.g., use of local building materials) and rarely encompassed sustainability decisions at the neighbourhood level and beyond. When the latter decisions *were* made, local authority often strongly guided decision-makers to do so. Economic feasibility was another reason for private sector decision-makers to consider sustainability.

Timing of decisions

Decision-makers made sustainable urban design decisions throughout the process. In particular, decisions were made during brief preparation (by local authorities), while designing and developing the urban design sites (by local authorities and the private sector) and when evaluating and selecting a design for planning approval (by local authorities) (see Figure 1). Thus, local authorities had more opportunities to consider sustainability at many stages of the process than did decision-makers in the private sector.

Level of detail of decisions

The three case studies demonstrated that the level of detail of decisions about sustainability depended on what was important in that area and who was making the decisions.

In London, sustainability was written into local authority planning briefs, guidance and policy. Planning and design officers also wrote about sustainability in the reports they gave to their planning committee. Nonetheless, the officers said sustainability was not a concept that was fully enforced through the planning system at the time of the case study in the 1990s. The private sector architect interviewed repeated these claims, stating that, due to restrictions on funding, he could not create an environmentally sustainable design (e.g., green roofs, greywater recycling).

In Sheffield, local sustainability policy was mostly absent in the early 1980s. Nonetheless, local authorities and the private sector emphasised dimensions of sustainability. For example, the decision by the local authority to keep a park as an open space, rather than develop on it, is rooted in environmental and social sustainability (i.e., parks provide an oasis in a dense, urban space; parks are amenities for neighbouring residents). Moreover, an entrepreneur's decision to create a mixed-use space for new retail businesses and leisure activities stemmed from his wish to help local businesses and create "a happening" in the city (i.e., promoting economic and social sustainability). Other decisions, such as allowing inner city housing, forming a neighbourhood association and creating a mixed-use site of office, retail and residential, highlighted the importance of social and economic sustainability.

In Manchester, sustainability was rarely mentioned in the earliest design and regeneration briefing documents for the international design competition. When it was cited, sustainability was found under regeneration, which mostly concerned economic growth. Thus, design competition teams did not know the full extent of the sustainability challenges in the deprived area. Moreover, during the judging of the design competition entries, sustainability took a back seat to value for money, how the entries looked, creativity, market awareness, compatibility with government and aspiration.

The revised urban design process with decision-making tools

Having analysed the case study processes and compared them with the generic process, the urban design process was revised to reflect two new insights: sustainability needs to be considered at every stage and a consistent set of tools will enable decision-makers to make the most appropriate choices for sustainability. The revised process contains five stages, as well as sustainability tasks, sustainability reviews, a legacy archive[1] and a suite of tools that have emerged from the *VivaCity2020* project for decision-makers to use (tools with an asterisk, '*', may be more useful at particular scales and types of urban design projects, such as a Local Authority masterplan) (see Figure 5).

[1] A legacy archive is a device used to store knowledge, information and recorded decisions from an urban design project. Decision-makers can look at the information to help them make decisions on their current project and future projects.

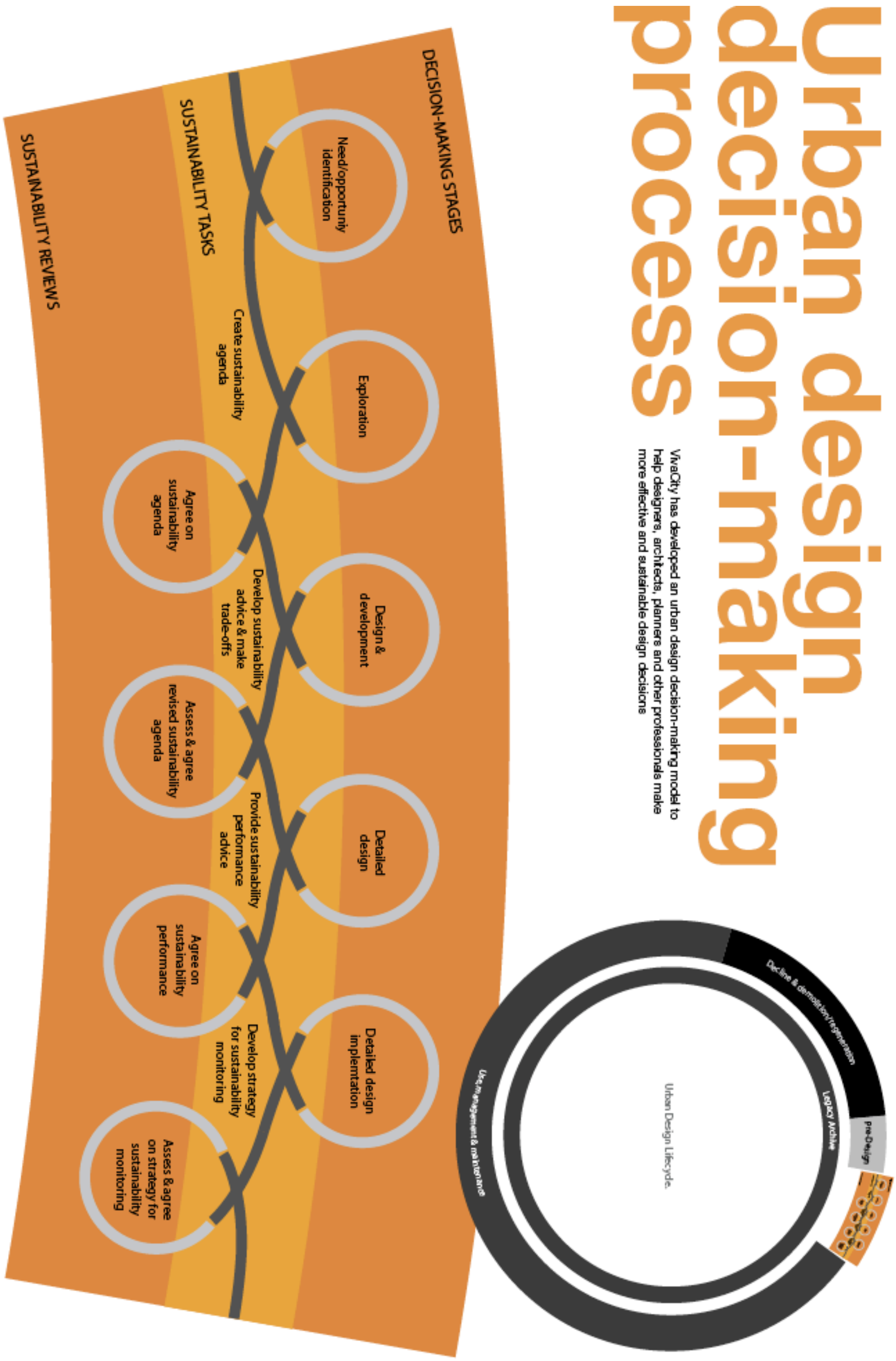


Figure 4. The revised urban design process. Source: *VivaCity2020*.

Stage 0: "Need/ Opportunity Identification." In Stage 0, an individual or team (e.g., local authority, land owner) identifies a need (e.g., more green space) or an opportunity (e.g., new family homes) for an urban design project. The identification of a potential location for the project as well as partnership opportunities also occurs here. It is important for the individual or team to consider economic, environmental and social sustainability factors at this early stage when making decisions about the project because critical issues and tradeoffs will already being to emerge.

Stage 1, 'Exploration.' In Stage 1, a Development Team is formed to explore the urban design project from a variety of angles (e.g., architecture, context, finances, sustainability) and develop the project further.

A Project Sustainability Group also is formed, consisting of people who will likely be involved through the lifetime of the project (e.g., construction agencies, developers, financiers/investors, local authority, residents). A Group leader will be appointed who has the appropriate skills for the position. It will be the leader's responsibility to ensure that new expertise is added to the team when necessary. In some cases, the Group may be only one or two people, especially when the project is small or the need/opportunity from Stage 0 is still being investigated. Their main task is to guarantee that sustainability is considered throughout the process.

Both sets of teams will take the outputs from Stage 0 and begin to formalise them into a Sustainability Agenda. It is essential that they understand the basic tenets of sustainability and work in concert to create a viable project and a Sustainability Agenda.

Sustainability Tasks. Between Stage 0 and the first Sustainability Review (see below), the Project Sustainability Group—with the help of the Development Team in some circumstances—creates a Sustainability Agenda based on knowledge, experience, information and decisions recorded in the legacy archive. The Agenda contains a ranked list of sustainability issues that the Group sees as important and will carry through to Stages 2 (Design and Development) and 3 (Detailed Design) of the project. It sets out in writing how the teams understand the sustainability issues and issue rankings within the project. This Agenda should be re-assessed throughout the process to ensure that existing and new sustainability issues are considered and ranked accordingly.

Sustainability Review. Before the Development Team begins designing and developing their ideas for the project, they must agree on the Sustainability Agenda with the Project Sustainability Group. Doing so gives both teams a chance to think about the sustainability issue rankings and to negotiate any tradeoffs on the issues.

Tools to use between Stages 0 and 2:

- Bibliographic review of mixed-use: organised by theme; includes books, web site, journals and conferences
- Environmental quality case studies: explains innovative, qualitative and quantitative methods for capturing environmental quality in London, Manchester and Sheffield; discusses findings related to residents' experiences within city centres and measured levels of greenhouse gases
- Housing case studies: shows residential areas in three city centres—London (Clerkenwell), Manchester (Hulme) and Sheffield (Devonshire Quarter)—and the

various types of housing that have been built in the UK from the 1820s until the present day

- Liveability postal survey: based on the Government's "liveability agenda" to capture residential satisfaction in an area. It comprises 24 questions, divided into four themes: upkeep and management of public space and buildings, road traffic and transport-related issues, abandonment or non-residential use of domestic property and anti-social behaviour
- Night-time economy and crime case studies: explores the relevant literature in detail as well as the night-time economy and crime in London, Manchester and Sheffield
- Retail and crime case studies: explores the relevant literature in detail as well as retail and crime in London, Manchester and Sheffield
- Space Syntax analysis: shows the relationship between street layout and residential property value using Council Tax Bandings, locational variables, age, property size and ambient density; shows the value and formation of urban centres by exploring the Space Syntax theory of Centre Formation, comparing different high streets using graphical representation and statistical analysis
- *Toilet user personas: each persona is an 'archetypal user', created in collaboration with user groups in research about city centre toilet provision
- *Toilet user surveys: used to indicate people's feelings about how provision meets, or fails to meet, the local community's needs
- *Urban design and the creative arts: using data from the research, two artists created videos and prints, giving an alternative insight into sustainability and the urban experience of city users and residents

Stage 2: "Design & Development." In Stage 2, the actions of the Development Team correspond to stages/phases in construction management and architectural processes (e.g., Phase 4, Outline Conceptual Design, of the Process Protocol; Stage C of the RIBA Plan of Work). During this time, the Development Team begins designing their plan and considering design and development issues pertaining to sustainability.

Sustainability Tasks. Between the first and second Sustainability Reviews, the two teams will generate Sustainability Advice as part of pre-planning application meetings. This task gives both teams an opportunity to give and seek advice about the sustainability of the project, and discuss sustainability tradeoffs. The tradeoff discussions may lead to a re-ranking of sustainability issues and a revised Sustainability Agenda, to be presented at the second Sustainability Review.

Sustainability Review. The Project Sustainability Group will discuss tradeoffs and agree the re-ranking of the Sustainability Agenda with the Development Team. This allows both teams to be involved in the process and understand what sustainability issues are being considered in the project. The Project Sustainability Group also will examine and agree the Development Team's preliminary designs.

Tools to use between Stages 2 and 3:

- Environmental quality case studies: see above
- *Inclusive toilet hierarchy: identifies a hierarchy of provision in reference to away-from-home toilets; used to inform debates about the number and types of accessible toilet cubicles in any context

- I-VALUL: a presentation, exploring residential burglary and street robbery and the value of personal and property security
- *Hulme case study: looks at the New Urbanist regeneration of Hulme, assessing whether the area has become a safer and more sustainable place to live
- Open Space Strategy: quantitative data for 30 housing schemes, including figure/ground ratios of buildings and open spaces, the extent and type of non-residential uses, the public/private designation of open spaces, the local street hierarchy and the type, height, transparency and permeability of building façades and secondary boundaries (e.g., walls)
- Spatial data analysis: used to map economic, social and land-use diversity in the case study areas using GIS. Can be used with Space Syntax to identify street and pedestrian routes and on-street surveys to identify pedestrian movement (data available for London and Sheffield)
- *Toilet user personas: see above
- *Toilet user surveys: see above
- External tools:
    - Complex Built Environment Systems: a group interested in developing solutions to practical design, construction and managements problems

- Cultural Planning Toolkit and Guidance
- Design Against Crime: research, educational material and policy initiatives that aim to improve design's effective in reducing crime
- Inclusive Design for Getting Outdoors: research consortium focussed on ways to improve the design of outdoor environments to enhance older people's quality of life
- Live Work Network: an organisation devoted to providing information on live/work units
- Space Syntax: an organisation providing an evidence-based approach to the planning and design of cities
- Street Design Index: uses comprehensive mapping of neighbourhoods, communities and routes to enable decision-makers to consider a wide range of urban design issues (e.g., fear of crime, surveillance, amenities, signage)

Stage 3: "Detailed Design." In Stage 3, the actions of the Development Team correspond to stages/phases in construction management and architectural processes, (e.g., Phase 5, Full Conceptual Design, of the Process Protocol; Stages D and E of the RIBA Plan of Work). During the time, the Development Team progresses in more detail with their designs, demonstrating an exhaustive understanding of design issues pertaining to sustainability.

Sustainability Tasks. Between the second and third Sustainability Reviews, the two teams will seek and provide Sustainability Performance Advice as part of pre-planning application meetings. This task will give both teams a chance to share information and knowledge about the proposed design and its potential performance in terms of sustainability ahead of the formal performance assessment at the third Sustainability Review.

Sustainability Review. Once the Development Team has created a detailed design for the project and discussed sustainability performance with the Project Sustainability Group, the latter will evaluate the design against the Sustainability Agenda. Agreement between the detailed design and the Sustainability Agenda allows a "go-no go" decision for planning application submission. Disagreement suggests that the two teams will have to look at the Sustainability Advice given previously and will have negotiate further sustainability tradeoffs. Without this review, the Development Team may feel less certain about the robustness of their planning application with respect to the design and to sustainability.

Tools to use between Stages 3 and 4:

- Toilet design templates: building on recommendations from a wide range of British Standards, this guide is used to help design accessible and inclusive toilets

Stage 4: "Detailed Design Implementation." In Stage 4, the actions of the Development team correspond to stages/phases in construction management and architectural processes (e.g., Phase 6, Coordinated Design, Procurement and Full Financial Authority, of the Process Protocol; Stages F through L of the RIBA Plan of Work). Pending planning permission, the project will be constructed during this time.

Sustainability Tasks. Once the project is built, both teams will consent to a Strategy for Sustainability Monitoring, which outlines management and maintenance plans for the site and the surrounding context in the short- and long-term. The strategy should incorporate a budget, timeline and a list of stakeholders who will manage and maintain the project over its lifetime.

Sustainability Review. The two teams will review and assess the Strategy for Sustainability Monitoring, using the legacy archive and the Project Sustainability Reviews to guide assessment. This assessment offers a formal benchmark against which future urban design decisions can be compared and evaluated.

Tools to use between Stages 3 and 4:

- Urban design process case studies: discussed in this paper
- Spatial data analysis: see above

Conclusions

This paper has demonstrated that, while cities cannot be designed in five easy steps, showing how urban design projects "come to be" and understanding where the gaps in knowledge lie certainly can help to illuminate a complex process and improve it. From the literature and the case studies, it was evident that sustainability and the tools used in decision-making were not made explicit nor considered consistently. The revised generic process takes these lessons and incorporates them into each stage, adding sustainability tasks and reviews for decision-makers to undertake. This gives stakeholders an opportunity to holistically evaluate sustainability within urban design projects and see where tradeoffs and negotiations lie. Having a consistent suite of decision-making tools to use at each stage of the process also helps in making more informed decisions about specific sustainability issues. The legacy archive can be utilised to capture the above information and store it for current and future use on urban design projects on that site and in the area. Finally, the generic process provides sufficient detail for sustainable decision-making without being too prescriptive, allowing for context-specific urban design that follows a loose series of actions. Perhaps it is not so difficult after all?

References

Atkin, B., Borgbrant, J., & Josephson, P.-E. (Eds.) (2003). Conclusions. In *Construction Process Improvement* (pp. 292-298). Oxford: Blackwell Science Ltd.

Austin, S., Steele, J., Macmillan, S., Kirby, P., & Spence, R. (2001). Mapping the conceptual design activity of interdisciplinary teams. *Design Studies, 22* (3), 211-232.

Barnett, J. (1982). *An introduction to urban design*. New York: Harper & Row.

Biddulph, M. (1997). An urban design process for large development sites. *Town and Country Planning, 66*, 202-204.

Boyko, C. T., Cooper, R., & Davey, C. (2005). Sustainability and the urban design process. *Engineering Sustainability, 158* (ES3), 119-125.

Boyko, C. T., Cooper, R., Davey, C. L., & Wootton, A. B. (2006). Addressing sustainability early in the urban design process. *Management Of Environmental Quality, 17* (6), 689-706.

Bressi, T. (1995). The real thing? We're getting there. *Planning, 61* (7), 16-21.

CABE & DETR (2000). *By design. Urban design in the planning system: Towards better practice*. London: Thomas Telford.

Carmona, M., & Tiesdell, S. (Eds.) (2007). Introduction. *Urban design reader* (pp. 1). Oxford: Architectural Press.

Canadian Institute of Planners. (2000). The urban design process. Retrieved 24 June 2004 from http://www.cip-icu.ca/English/aboutplan/ud_proce.htm

CLG. (2006). *Strong and prosperous communities- The local government White Paper.* London: TSO.

Cooper, R., Aouad, G., Lee, A., Wu, S., Fleming, A., & Kagioglou, M. (2005). *Process Management in Design and Construction.* Oxford: Blackwell.

English Partnerships. (2000). *Urban design compendium*. London: English Partnerships.

Gosling, D. (2002). *The evolution of American urban design*. New York: Wiley & Sons.

Heritage Lottery Fund. (2000). *Building projects: Your role in achieving quality and value.* London: Heritage Lottery Fund.

Kagioglou, M., Cooper, R., Aouad, G., Hinks, J., Sexton, M., & Sheath, D. M. (1998). *A generic guide to the design and construction process protocol.* Salford: University of Salford.

Macmillan, S., Steele, J., Kirby, P., Spence, R., & Austin, S. (2002). Mapping the design process during the conceptual phase of building projects. *Engineering, Construction and Architectural Management, 9* (3), 174-180.

Nelessen, A. C. (1994). *Visions for a new American dream: Process, principles, and an ordinance to plan and design small communities* (2nd ed.). Chicago: Planners Press.

ODPM. (2002). *Sustainable communities: Delivering through planning.* London: ODPM.

ODPM. (2003). *Sustainable communities: Building for the future.* London: ODPM.

ODPM. (2004). *Diversity and planning: Research report on planning policies and practice*. London: ODPM.

ODPM. (2005a). *Planning Policy Statement 1: Delivering sustainable development.* London: ODPM.

ODPM. (2005b). *Sustainable communities: People, places and prosperity*. London: ODPM.

ODPM. (2006). *The Office of the Deputy Prime Minister's Sustainable Development Action Plan. Securing the future: Delivering UK sustainable development strategy*. London: TSO.

Okubo, D. (2000). *The community visioning and strategic planning handbook*. Denver, CO: National Civic League Press. Retrieved 20 July 2005 from http://www.ncl.org/publications/online/VSPHandbook.pdf
Oxford English Dictionary. (2005). Definition of the word 'process'. Retrieved 8 March 2005 from http://dictionary.oed.com/cgi/entry/50189148?query_type=word&queryword=process&first=1&max_to_show=10&sort_type=alpha&result_place=4&search_id=mN9p-XRa38f-2385&hilite=50189148
RIBA. (1999). *RIBA Plan of Work*. London: RIBA.
Roberts, M. B. (2003). *Making the vision concrete: Implementation of downtown redevelopment plans created through a visioning process.* Unpublished doctoral dissertation proposal, University of California, Irvine, Irvine, California.
Rogers, R., & Power, A. (2000). *Cities for a small country*. London: Faber & Faber.
Rowland, J. (October 1995). The urban design process. *Urban Design Quarterly, 56.* Retrieved 14 July 2004 from http://www.rudi.net/bookshelf/ej/udq/56/udp.cfm
Rowley, A. (1994). Definitions of urban design: The nature and concerns of urban design. *Planning Practice & Research, 9* (3), 179-198.
Smith, J., & Jackson, N. (2000). Strategic needs analysis: Its role in brief development. *Facilities, 18* (No 13/14), 502-512.
Wates, N. (April 1996). A community process. *Urban Design Quarterly, 58 Supplement.* Retrieved 14 July 2004 from http://www.rudi.net/bookshelf/ej/udq/58conf/cp.cfm
Wates, N. (July 1998). Process planning session. *Urban Design Quarterly, 67 Special report: Involving Local Communities in Urban Design.* Retrieved 14 July 2004 from http://www.rudi.net/bookshelf/ej/udq/67_report/method_10.cfm
Woodhead, R. M. (2000). Investigation of the early stages of project formulation. *Facilities, 18* (13/14), 524-534.

The interplay of market forces and government action in the achievement of urban sustainability: the case of Auckland, New Zealand

Assoc. Prof. John Boon

Unitec, New Zealand

This is a case study of urban intensification in the central business district (CBD) of Auckland. The city is the commercial centre of New Zealand with a population of 1.3m. It is a sprawling city with low population density and a high dependency on private motor vehicles for transport. Auckland has recognised the need to contain urban growth within its existing urban perimeter and achieve greater intensification. Progress has been made in this regard within the CBD where significant growth in inner city residents is evident. This has been achieved through private developers reacting to market demand rather than through public sector initiatives. The availability of finance for development and investment is seen as a key enabling element. Tax advantages for investment in property and planning bonuses for residential development are also significant elements in the complex mix of matters that has enabled this urban intensification. However the quality of development is marginal. Services for the expanded inner city population have developed in line with growth.

Keywords: apartment development, planning bonuses, tax incentives, urban intensification

Introduction

Movement towards the achievement of urban sustainability is a complex process that requires action by both the public and private sectors. This paper attempts to analyse the interplay of market forces with public sector activity in the area of development of intensification of inner city living in Auckland New Zealand. Within the context of this paper the growth of inner city residential accommodation is taken as a proxy for urban intensification. It is acknowledged that other forms of development and use form part of the intensification mix however in the case of Auckland the lack until recently of people living in the inner city has been viewed as a significant social problem and is also the key to intensification contributing to sustainability. An increase in business activity in the CBD (central business district) whilst people continued to live in the suburbs would increase the volume of commuting and hence energy consumption and pollution.

Research Method

This case study of Auckland has been assembled from a wide variety of sources. Wherever possible published data has been used however some information has been gathered from the authors own observations over time and from informal conversations with members of the property development community.

The Context

By the standards of most cities Auckland's history is short. However its history is almost as long as the history of European settlement in New Zealand. Bush (1971) describes the beginnings of the city occurred on 20th October 1840 with the purchase of 3,000 acres from the indigenous Maori people by Captain Hobson on behalf of the British Crown for the purpose of establishing a capital for the fledgling colony. The area is situated on a narrow isthmus of land between two large harbours that almost divide the North Island of New Zealand. The area had a long previous history of Maori settlement. Auckland was originally established as the capital of New Zealand, however that function was shortly transferred to Wellington in order to better enable the Governor General to deal with unrest among southern settlers.

The initial growth of the Auckland region came from the provision *of "commercial and transport services linking the timber miller, flax gatherer, gold miner and agriculturist with the foreign industrialist and entrepreneur"*(Bush 1971p115).

The Auckland region now has a population of approximately 1.3m (2006 census) which is about one third of the total population of New Zealand. It has a diverse economic base mainly comprising commercial services, light industry and import and export activities through its sea port and international airport. It is the largest city in New Zealand and the principal commercial centre. Its significance as the principal commercial centre has grown progressively over the last three decades, it now holds a dominant position in the non rural economy of New Zealand. Auckland currently has a population growth rate of approximately 2.5% (ARC 2007) arising from, natural growth and internal and external migration.

Auckland's growth in the post war period has occurred firstly within a national economic regime that until 1984 provided protection to local industry through import controls and encouragement to export through tax incentives. However since 1984 a liberal economic management regime has existed with few controls or restrictions. In the 2009 Heritage Foundation / Wall Street Journal survey New Zealand was rated fifth out of 179 countries surveyed for economic freedom. It is also substantially free from corruption with a score of 94% in the same survey which notes that Transparency International ranked New Zealand first in its Corruption Perception Index for 2007.

The evolution of Auckland can be seen as relating to Harris and Ullman's (1951) "multiple nuclei theory" i.e. a number of at first independent settlements have gradually amalgamated into a conurbation.

Overlaying this pattern is a strong pattern of suburbanisation from the 1940's onwards. This pattern of suburbanisation was encouraged through the 1960s and 70s by two central government policies. Firstly the development of an effective (at the time) road and motorway system facilitated efficient suburban commuting to the city centre by private car. Secondly a policy of providing subsidized mortgages to first home buyers provided they purchased a new house within a relatively low price limit; this encouraged the development of new houses on the fringe of the conurbation. The net effect of these policies has been that a conurbation with a largely suburban characteristic has evolved. Aucklanders typically live in single storey detached houses on a section of 6-800m^2 or more. About 72% (2006 Census) of houses are owner occupied. Auckland is a low density city with an average of 19 persons per hectare (Ceder 2008) this low even by Australian and American standards.

A large percentage of Aucklanders travel to work by private motor vehicle using the motorway system. Public transport is mainly by bus. Suburban commuter trains are available to some areas but are not extensively used. Auckland has no heavy industry, port activities are immediately adjacent to the central business district, light industry is now largely dispersed to suburban areas. Growth of the city has resulted in the motorway system becoming congested to the extent that commuting by car from the outer suburbs is now difficult and time consuming. Approximately 60% of peak time journeys into the CBD are by private car (ARTA 2007).

Government of the region is exercised at three levels. The national government's responsibilities include major road, rail track provision, law and order, healthcare and education. Regional strategy and planning is exercised through the Auckland Regional Council. Regional infrastructure provision and maintenance including road, water and sewerage is provided by a separate body Infrastructure Auckland and public transport is provided by the Auckland Regional Transport Authority (ARTA). Local government is exercised through four city and three district councils whose responsibility include town planning, local roads, water supply and drainage. This breakdown of responsibilities is not entirely satisfactory. The region has over time been subject to a number of restructures and the regional / local split of responsibility is currently the subject of a Royal Commission of Enquiry due to report in March 2009.

The Auckland Regional Council (ARC) has the following published strategies which are relevant to this paper. Infrastructure Auckland, the ARTA and the Local Councils are required to act to implement these strategies:

- Auckland Regional Growth Strategy. This was published in 1999 and provides a framework for managing growth through to 2050. It sets boundaries for urban development and designates areas for urban intensification.

- Auckland Regional Land Transport Strategy. First published in 1999, updated in 2003 and revised in 2005. This sets the strategy for the development of the regions roads, rail and ferry systems.

- Auckland Regional Economic Development Strategy. Published in 2002 this sets a strategy for economic growth through to 2022.

In addition the ARC has a Long Term Council Community Plan. This is a requirement for all regional and local councils under the Local Government Act 2002. It provides a ten year plan for development of the region based on "community outcomes" and is updated at three yearly intervals. The current plan was published in 2006 for the 2006 – 2016 period.

All the Local Councils have similar Long Term Council Community Plans.

Auckland has been subject to a Town Planning regime since the Town Planning Act 1926. Town Planning is now exercised through the Resource Management Act 1991. Planning is implemented through a system of "District Plans" administered by the city or district council these impose zoning controls that restrict uses to which buildings can be put in each zone. They also impose development controls including site intensity, height and distance from boundary as well as transport controls including road access from properties and carpark provision regulations.

Urban Intensification

Within the context of urban sustainability the management of growth through intensification rather than continuing urban sprawl is generally regarded as a good thing. For instance Jenks, Williams and Burton (2000) argue "*Many hopes for sustainable urban futures rest on the fact that compact cities, produced through a process of urban intensification, can provide benefits in terms of resource efficiency, reduced travel demand, and liveable environments" (p17).* The UN Centre for Human Settlements in its report "Cities as Solutions in an Urbanizing World" (1996) argued that rural areas, small towns and low density outer suburbs have much higher consumption of resources than within intensely developed cities. The advantages the report claims for intense urban development includes.

- Lower cost per household for the provision of services such as water, waste water rubbish disposal, telecommunications, healthcare, education emergency services etc.

- Efficient use of resources through the concentration of production and consumption including the reclamation and recycling of waste materials.

- Reduced usage of land per head of population

- Reduced use of motor vehicles.

However it is also recognized that intensification with its concomitant resource efficiency on its own is not enough, cities must also be ecologically and socially sustainable. Newman and Kenworthy (1999) argue *"It is possible to define the goal of sustainability in a city as the reduction of the city's use of natural resources and production of waste, while simultaneously improving its livability, so that it can better fit within the capacities of local, regional and global ecosystems (p7).* Giradet (2004) postulates *"A 'sustainable city' enables its citizens to meet their own needs and to enhance their well-being, without degrading the natural world or the lives of other people, now or in the future. (p6).* He goes on to acknowledge that liveability and sustainability are not always the same thing. Within this context the practice of zoning cities into separate activities so that work and living are split into separate locations comes under criticism as it requires greater movement of people and hence greater use of automobiles as well as public transport than if work is available within walking or cycling distance. Newman and Kenworthy (1999) cite Bernick and Cervero (1997) to support this type of argument. Giradet also advocates for greater mixed use areas for social as well as transport economy reasons and quotes Jaime Lerner the former mayor of Curitiba *"the more you mix, the more human the city becomes".*

Policy and Planning for Intensification in Auckland

Within Auckland growth through intensification rather than further sprawl has been clear policy since the publication of the Regional Growth Strategy in 1999. The strategy provides a "growth concept" which includes the following key features (these have been abbreviated from the strategy document):

- The effects of growth are managed by promoting compact urban environments
- Most future growth is within the existing metropolitan area with development outside the current area only where environmental, accessibility and community principles can be met.
- Most urban growth is focused around centres of varying sizes and major passenger transport routes.
- The growth concept places less emphasis on general suburban infill as a way of accommodating growth and focuses more on redevelopment and intensification in specific areas.

The strategy states:

The Growth Concept is based on compact urban environments. This means where urban growth, whether as part of the existing metropolitan urban area, a satellite town, or rural or coastal town, it should result in a compact urban form to avoid spreading the effects of urbanisation over a greater area. The Growth Concept puts greater emphasis on urban intensification than urban expansion (p28).

Since the publication of the Growth Strategy the local councils of the regions have amended their District Plans to allow for the intensification in the specific areas and to contain development within the designated perimeter. In some cases these amendments have sought to encourage mixed use developments by the creation of "Mixed Use" designated areas. Where greenfield development has been permitted it has generally been of a compact nature. Primarily this has been in the Albany and Flatbush areas.

However in a substantially private enterprise economy the publication of a strategy and revised District Plans does not ensure that the development envisaged by the authors actually takes place. The District Plans particularly are enabling mechanisms, they permit such development to take place, the conduct of the development is left to private enterprise. Redevelopment to achieve intensification requires property developers to assemble finance, acquire land, carry out the redevelopment and on-sell the completed development to investors or owner occupiers. For this to happen a complex set of market conditions needs to be in place. Further for the developments to contribute to the economic and social sustainability of the urban area issues of mix of use, urban design and social development also need to be addressed. Within the New Zealand context much of this is left to the invisible hand of the market.

In this next section the evolution of intensification within the Auckland central business district (CBD) will be considered.

Residential Activity Within the CBD

Whilst in the early days of development of Auckland people lived in the central area movement of residential activity from the central area to the suburbs occurred from the 1930s onwards. By the 1970s a lack of people living in the CBD was seen as a problem. A 1971 survey noted that *'over 64,000 people were employed in the central area yet those who actually lived there can be numbered in hundreds"* (Auckland City Town Planning Department 1971 p58). This situation was seen to be socially undesirable - *"Facilities provided to meet 'nine to five' demands during weekdays are largely under-utilized during weekends. The presence of more people is likely to reduce the incidence of crime and vandalism in the often empty city streets"* (Betts and Grove 1979 p6).

Throughout the 1970's and 80's the Council sought to remedy the situation, numerous reports were prepared and several conferences organized. The consensus of opinion particularly during the 1970s and early 80s was that the only means of getting people back to living in the inner city was for government to provide subsidized accommodation. However for reasons largely of inertia no action was taken. By the mid 80's such notions of direct government action had fallen out of favour but the reintroduction of people living in the inner city was still seen as desirable. Council attempted to encourage residential development by offering bonuses on permissible floor areas where developments contained residential accommodation, rating relief during development and by waiving a development levy on residential development. These moves had little effect and only a very minor level of residential development occurred until 1992 (Boon 1996)

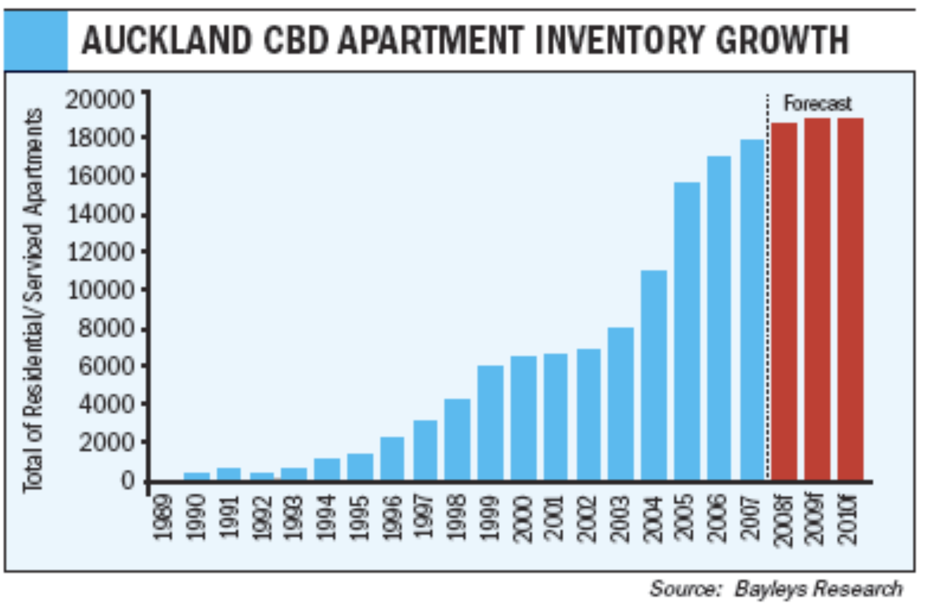
Around 1992 a dramatic turn around in the development of inner city accommodation occurred. In 1991 the number of inner city residential units excluding state owned apartments and university accommodation was approximately 365, by the end of 1996 approximately 3,000 units had been added to the market. This turnaround appears not to have arisen from any government policy but rather from market driven changes. These were identified by Boon 1997 as:

- The availability of a stock of redundant office buildings of low value suitable for conversion to apartments - In the early 1990s following the stock market crash and general downturn in the economy there was a high vacancy rate in commercial buildings in central Auckland. This resulted in tenants moving to newer buildings and office buildings built during the 1950s and 60s becoming vacant. After a time they were sold at prices considerably below replacement costs and provided relatively cheap structures for conversion to apartments. The first apartment developments in this period were conversions of these office buildings.
- Changed economics of apartment development - The available stock of redundant office buildings enabled relatively cheap apartments to be delivered to the market and helped to establish the inner city living lifestyle. Once the lifestyle was established it appears that changes in market perceptions enabled higher prices to be achieved and made the development of new apartments an economic proposition.
- Life style changes - Four factors seem to have brought about changes in lifestyles that made inner city living acceptable to New Zealanders these are:
    1. new immigrants and returning New Zealanders with experience of inner city living sort to repeat that experience in Auckland
    2. the growth of Auckland had reached the stage where commuting from the outer suburbs had become an unattractive, time consuming and expensive proposition
    3. recreation and entertainment facilities in the city centre had improved

4. the first wave of baby boomers had reached that stage in life where their children had grown up and left home. A city apartment and weekend retreat or boat were therefore now viable propositions.

- Normal cycle of inner city decay and renewal - by the early 1990s much of the immediate perimeter of the inner city had been regentrified. It was therefore a natural progression for people looking to avoid commuting from the suburbs to look within the city centre itself.
- Growth in sophistication of the property market - It was only in the 1980s that the mortgage market in New Zealand became generally willing to lend on apartment titles.
- General liberalization of the economy - since 1984 the New Zealand economy has undergone a process of economic liberalization. This has had a significant impact on peoples ability to develop a lifestyle of their own choosing. Amongst the choices people have made is to move back into the inner city.

Since that time the development of apartments has continued and accelerated in 2003 refer fig 1 below.



Analysis of 2001 census data (Statistics NZ 2005) indicated the following breakdown of inner city apartment dwellers:

- Median age 29
- Median income $26,500
- Working 92%
- Renting 72%
- European 65%
- Asian 31%
- Other 4%
- Families with children 9%
- Singles/couples 60%
- Flatmates 31%

Significant in this is the percentage of people renting at 72% compared with a national figure of 29% at the same census. Generally the apartments have been sold by the developers to investors who own either a single or small number of apartments. Investment companies or other non-government organisations who own large numbers of properties do not exist in New Zealand. The central governments social housing arm Housing New Zealand owns few apartments in the CBD all of which predate the 1980s. Similarly the City Council's social housing portfolio in the CBD predates the 1960s.

This movement towards urban intensification can therefore be characterised as having been enabled by District Planning regulation but brought about by the interplay of private sector developers, private investors and individuals and childless couples wishing to rent rather than buy.

Market Forces and Planning

The timing of the start of this growth in inner city apartment development around 1992 which substantially predates the Growth Strategy published in 1999 indicates that it is substantially driven by the market forces described above and coincides with rather than is driven by public policy considerations of sustainability. However it can be argued that the acceleration of development in the 2003 – 2005 period was driven in part by the containment of the boundaries of urban sprawl set down by the Growth Strategy which had the effect of driving development activity away from the creation of further sprawl and into urban intensification.

However there are other dimensions to this growth of inner city apartments. The first is the evolution of the finance market so that it could support both development of and investment in apartments. Before the economic liberalisation reforms of the 1984 Labour government the New Zealand finance industry was small unsophisticated and heavily regulated. Loans for development purposes were hard to obtain. Loans for investment purposes for individual houses were obtainable but loans on unit titles of multi-storey blocks were difficult to get. Following the economic liberalisation things changed significantly. Firstly the major trading banks have emerged as the dominant players in the market having taken over most Building Societies and similar entities. With regard to property development in the second half of the 1980s the trading banks became significantly involved mainly lending on commercial rather than residential developments. When the commercial property market collapsed at the end of the 80s they lost significant sums on bad loans. As a result they adopted more conservative policies from then on. With regard to apartment developments, from the early 90s onwards typically trading banks were not willing to lend more than 60 – 80% of the total cost of a development (Burson 2006). The funding gap between the trading bank loan and the total cost of development led to the emergence of second tier finance companies as players in the market providing mezzanine finance to property developers to bridge the funding gap. Without this mezzanine finance it is unlikely that most apartment developments would have proceeded. In the period 2007-8 most of these finance companies collapsed as a result of risk exposure to property developments. Until new means of filling the funding gap between trading bank loans and the total cost of development emerge further development of apartments and hence further urban intensification is unlikely.

With regard to investment finance, the willingness of banks to lend on unit titles since the early 1980s has clearly been a major enabler of the emergence of the apartments for the investment / rent market. As a further indicator of the influence of the finance sector on urban development it is worth noting that since about 2005 banks have been wary of lending on apartments under 40 or

45m^2 (eg National Bank 2008). As a result the practice of developing small studio apartments has virtually ceased.

The second dimension is that of tax benefit from property investment compared to other classes of investment. Under the New Zealand tax system investors are able to write off losses on investment property against their personal income tax essentially on the difference between rental income and the cost of ownership, management and maintenance. However when they sell the property the capital gain is not taxed. With significant capital gains being made on property in the period under consideration this has made investment in property a more tax efficient and hence more attractive investment than other forms of investment (Westpac 2007).

It can therefore be argued that the availability of finance for development and investment together with the tax advantages of investing in property have been significant elements in the mix of market forces that have led to urban intensification in the case of Auckland.

There is also a bias in the District Plan that encourages the development of residential rather than commercial premises. The development controls relating to site intensity in the CBD effectively allow a site to be developed to twice the level of intensity (floor area relative to site area) compared to commercial development. At the prices that have prevailed in the period this has meant it has generally been easier to do profitable residential rather than commercial development.

However intensification is only one dimension of achieving a sustainable city as noted above there are other dimensions to sustainability.

Quality of Apartments

As the development of apartments started to have a significant impact on the fabric of central Auckland public concern started to be raised about the quality of the apartments themselves and the impact of poorly designed apartment blocks on the urban environment.

With regard to the apartments themselves the concern centred on the apartments being too small, having poor outlooks, poor natural ventilation and containing rooms with internal spaces that had neither natural light nor ventilation. These concerns were of sufficient volume that the city council investigated and undertook public consultation of the matter in 2004. The outcome of this process was that an amendment to the District Plan was introduced (clauses 6.15 & 6.16). These amendments imposed controls on the minimum size of apartments, the mix of apartment types in a block (studio, 1 bedroom, 2 bedroom etc), the availability of natural light into spaces and minimum outlook for the apartments.

Similarly about the same time the city council took action to introduce Urban Design standards. Initially a Mayoral Task Force was appointed to investigate the problem. The led to a report in 2005 and the introduction of a system of peer review by an Urban Design Panel. This body does not have statutory powers but reviews all development proposals in the CBD and provides advice to the decision making bodies. In 2007 an Urban Design Framework was published to provide further guidance.

The need to introduce these controls can be seen as an indication that an unregulated free market cannot be relied upon to provide some qualitative aspects of sustainable urban development.

None of the apartments have been assessed by any formal environmental rating system. Currently in New Zealand a Green Star rating system only exists for office buildings.

Provision of Services to Inner City Residents

Another dimension of sustainability in the inner city is the ability of residents to obtain the services they need to sustain themselves and have satisfactory social interactions.

As the established centre of the city, the CBD already contained many public services that residents of the new apartments can access within walking distances or short rides on public transport. These include the public library, art galleries, the museum, movie houses, concert halls and theatres etc. In terms of healthcare the main regional base hospital is located adjacent to the CBD and facilities such as general practice clinics, dentists etc already existed to service the day worker population or are available in adjacent inner suburbs. Tertiary education is provided by two universities and preschool facilities are available. Primary and secondary education is available in adjacent inner suburbs. The increase in the inner city population has enabled these services to be better utilised and has avoided the need to provide additional facilities if the same people had instead located themselves in greenfield developments on the periphery of the city.

More recent development of public services and facilities have included the provision of public spaces and walkways in the redeveloped viaduct basin area (completed 1999) and the redevelopment of the pedestrian areas of Queen St, the main street, to provide an attractive urban environment (completed 2008). These have been funded in part from development levies and the increased rating (local property tax) base that is derived from apartment developments.

The council has also been responsible for initiating the development of a performance arena for rock concerts etc. This was developed through a public private partnership and completed in 2007. It is operated by the private partner and has made a significant contribution to expanding the entertainment profile of the city.

With regard to provision of services by the private sector Queen St itself is a traditional strip retail street. In the 70s and 80s it struggled to compete with the new shopping malls in the suburbs. However in the last decade it has had a noticeable resurgence. Most major retail chains for categories such as fashion, fashion accessories, electronic goods, books, records, DVDs, travel, banking etc are present along with retail outlets focussed on tourists. In addition High St which runs parallel to Queen St has evolved as a boutique fashion precinct.

Fashion and food to go outlets have increased in number and more stay open on an evening to cater for residents as opposed to their traditional customer base of day workers. This is a significant change.

The number of bars has not changed greatly. The liquor trade tends to remain centred on traditional pubs however most have been refurbished and re-imaged and are noticeably more active on an evening. The exception to this is the viaduct harbour area which was redeveloped around 1999 which has a precinct of cafes and bars surrounding the waters edge.

The most noticeable change has been in the area of convenience shops and supermarkets. In the early 1990s there were no supermarkets and very few convenience shops (Hames Sharley 1991) Since that time two major supermarkets have been developed one to the east and the other to the west of the CBD. In addition numerous convenience stores have opened within existing retail spaces. Many of these are part of a franchised brand, however some are operated by individual owners.

In addition to its role as a direct provider of services the city council has the ability to facilitate or debar the development of private sector services particularly through the operation of the zoning provisions of the District Plan and operation of various licensing laws. In practice most of the new or expanded commercial services have been provided without the need for action of the part of Council. Existing zoning laws allowed most of the required services. Two exceptions to this are significant. The first is that the creation of the two supermarkets described above required changes to the District Plan. The second relates to activities in the inner suburbs adjacent to the CBD. These areas are mainly zoned for relatively low density housing, however within them pockets of commercial land with a zoning known as "Business 2" exist. This land has traditionally been used for local retail services and services such as auto mechanics, panel beaters, dry cleaners, small printers etc which service the needs both of the CBD and inner suburbs. However the Business 2 zoning also permitted medium density housing. High demand and hence high prices for such housing led to much of this land being redeveloped as medium density housing and hence the erosion of the availability of such services. The City Council considered this to be unacceptable and in 1999 introduced changes to the District Plan such that residential development is no longer possible on Business 2 land.

A 2003 survey indicated most residents were satisfied with the services available to them in the inner city. However noise was seen as a significant problem (ACC 2003). In the Mercer Quality of Living survey 2008 Auckland rated 5th overall.

Now and Into the Future

At the time of writing this paper (early 2009) development of further inner city apartments is almost at a complete halt. Several significant developments that were known to be in the planning phase and in some cases obtained building consents have been put on hold and are not proceeding to construction (Bayleys 2008).

Reasons for this appear to be in part associated with the general global downturn arising from problems with the finance industry flowing on from the sub-prime market collapse in the USA starting in 2006. This has led directly to a lack of development funding in the local market and indirectly to investor nervousness and hence an unwillingness to commit to purchase agreements before construction of the building commences (a requirement of the banks to supply development finance).

In addition to the global factors a number of local factors also exist which do not support further development. These include the collapse of the local mezzanine finance industry described above making developments very difficult to finance. Nervousness in local investor sentiment has also been increased by the collapse of a prominent property investment promoter Blue Chip in early 2008, together with negative publicity associated with problems arising from leaky buildings. There are also expectations of further price decreases for residential property. In a recent newspaper article economic commentators varied in their positions but predicted price decreases of between 5 and 42% in the next year (Herald 6th January 2009).

Whilst it does not appear to be a significant issue at this time it is likely that a point will be reached where land assembly will become an issue slowing further intensification. Much of the inner city is divided into small lots with fragmented ownership. This can create a significant barrier preventing private developers assembling large enough parcels of land to create satisfactory developments from either a short term economic or long term sustainability perspective. A recent government discussion document (Department of Internal Affairs 2008) has identified this as a potentially significant issue and suggested that government action through such means as creating powers of compulsory purchase may be necessary.

Conclusion

From a public policy perspective urban intensification can be regarded as development that supports the desirable goal of urban sustainability.

In the case of Auckland the intensification that has been achieved through the development of inner city apartments represents a significant shift in lifestyle away from living in a detached suburban house which until recently has been the almost universal choice of Auckland residents. This intensification appears to have been very substantially a private enterprise led initiative driven by a combination of:

- People wishing to live in the inner city rather than the suburbs, most often as tenants.
- Small investors seeking to invest in real estate and take advantage of the tax breaks available.
- Developers seeing the opportunity and being willing to take the risks.

Supporting these activities has been:

- A financial system that has enabled developers and investors to access the funds they need. The importance of this condition has been highlighted by current conditions where the absence of such funding means that apartment development is effectively not possible.
- Expectations of ongoing increases in values giving investors expectations of tax free capital gains.
- An enabling District Planning system with a bias towards encouraging residential development.
- A corruption free system meaning the process of development and investment is predictable and reliable.

However whilst the market has delivered the desired intensification in quantitative terms it has not in qualitative terms. Auckland's experience has been that design controls on individual apartments as well as urban design controls are necessary.

With regard to services for the increased number of inner city residents many services already existed and are now better utilised illustrating one of the benefits of intensification. Both public sector and private sector have been able to move in a satisfactory manner to provide additional services where required.

Whilst it has not been a barrier to date land assembly may become a significant barrier in the future.

References

ACC; 2003 "Auckland Inner City Living Survey Results" www.aucklandcity.govt.nz downloaded 13.01.09.

ACC; 2005 "Designing Auckland: a springboard for action" report of The Mayoral Task Force on Urban Design." Auckland City Council

ARC; 2007 "Growth of Auckland, Dynamics of Population Change" Auckland Regional Council Report.

ARTA; 2007 "Auckland Regional Transport Authority Annual Report 2006-7"

Auckland City Council Town Planning Division; 1971 "Central Area Survey: Data collected for the preparation of a plan for the future development of the central area of Auckland".

Bayleys; 2008 "Residential Property Research – Auckland CBD Apartments" Bayleys Research; Auckland.

Bernick, M. & R. Cervero; 1997 "Transit Villages in the 21st Century" McGraw Hill; New York

Betts J. & D. Grove; 1979; "Inner City Living - Planning Issues"; Proceedings of The Rebirth of The Inner City: A Seminar on Housing People in the Heart of Auckland City; Auckland Civic Trust; Auckland

Boon J.; 1997 "Urban Regeneration in Moderate Size Cities – The Case for Minimal Government Intervention". Asian Planning Schools Association Congress, Bandung.

Burson G. 2006 "Property Development Finance" Unpublished presentation to Unitec students

Bush G.W.A.; "Decently and in Order: The Centennial History of the Auckland City Council"; Collins; Auckland.

Ceder A. 2008 "Getting Auckland Moving" in Ingenio The University of Auckland Alumni Magazine; Spring 2008.

Department of Internal Affairs; 2008 "Building Sustainable Urban Communities" Discussion Document; DEIA; Wellington.

Giradet H.; 2004 "Cities, People, Planet" Chichester; Wiley Academic.

Harris C. D. & E.L. Ullman; 1951 "The Nature of Cities" in P.K. Pratt & A.J. Reiss (eds) Cities and Society; The Free Press.

Heritage Foundation: 2009 "Heritage Foundation / Wall Street Journal Survey of Economic Freedom" www.heritage.org/index/country/newzealand downloaded 14.01.09.

Jenks M., K. Williams & E. Burton; 2000 "Urban Consolidation and the Benefits of Intensification" in G. de Roo & D. Millar (eds) "Compact Cities and Sustainable Urban Development"; Burlington; Ashgate Publishing.

Newman P. & J. Kenworthy; 1999 "Sustainability and Cities, Overcoming Automobile Dependency" Washington DC; Island Press.

Statistics NZ 2005 “Downtown Dwellers 2005 New Zealand’s CBD Residents”

Westpac; 2007 “Rent Apart: Why rents have barely risen when house prices have doubled” Westpac Economic Research Unit report; Wellington.

Sustainable urban planning in Iran

Azadeh Arjomand Kermani[1], Prof. Eric Luiten[2]

1 – University of Siegen, Germany

2 – Delft University of Technology, Netherlands

Sustainable designs as well as ecological and geographical considerations are issues of key importance in urban planning of old Iranian cities. In a wide country such as Iran, with different climatic zone, traditional urban designers and architects have presented a series of logical solutions for human comfort. This paper explores the influence of Persian culture on Iranian cities and concentrates on principles of sustainability as affected by climatic and geographical elements. The aim of this research is to investigate traditional urban settlements of Iran as examples of sustainable urban form and demonstrate how past successful experiences can inspire modern urban planners and designers. This paper will try to answer questions such as how many great cities were designed and erected in arid region like Iran and how these cities are able to function and live during history and by which ways previous urban designers have solved the climatic and geographical problems.

This sustainable design has been used in past urbanism experiences in Iran in many aspects but in this paper the most important ones will be introduced. The main aim is to mention the importance of climatic and geographical conditions on formation and design of Iranian cities.

1. Urban structure orientation

Settlement location was selected due to some specific qualities such as connection with major roads, commercial importance, regional centrality, soil conditions, absence of floods, earthquakes and other unexpected disasters and so on.

One of the most basic principles of traditional Iranian urbanism is orientation of the city according to a specific direction which was derived from wind direction, sun exposition, climatic and geographical factors. This specific orientation is called urban ROON in Iranian traditional urbanism vocabulary. There are three different orientations in Iranian cities and it caused these cities to answer all inhabitants' ecological needs and make urban form really sustainable.

2. Regard to water sources in urban planning

Water as a natural element in urban planning of Iranian cities is considered in many aspects and has always been an essential factor in Iranian towns.

Iran is a vast country with different geographical zones and water appears in different forms. Water source had an important role in urban design and land use of Iranian cities and I will explain it comprehensively. In this part I mention just some samples of its use and effect in traditional Iranian cities and I divide them into two major groups of man made water sources: Ghanat and Maddi and natural forms such as rivers and springs.

3.Garden cities

Some of old Iranian cities have been designed as a garden city and this plan was derived from their agricultural and economical role in the region. Consideration of this fact results in social and economical sustainability of traditional Iranian cities. As perfect examples of these garden cities I will introduce Isfahan as a designed garden city and Bam as an organic one.

Conclusion

With attention to the results that are achieved from this quest in urban design experiences of historical Iranian cities and with regard to this fact that old cities are still responding to functional and psychological needs in the best way, it is necessary to learn from these lessons and benefit from appropriate urban structure orientation, site circumstances and natural, regional potentials in designing new cities and also expanding existing cities to enrich urban space and make the cities worth living.

Keywords: Qanat, garden city, traditional Iranian cities, water management, sustainable design

Sustainable designs as well as ecological and geographical considerations are issues of key importance in urban planning of old Iranian cities. In a wide country such as Iran, with different climatic zone, traditional urban designers and architects have presented a series of logical solutions for human comfort.

Urban environment is defined as a place that covers all natural and man-made aspects which concentrated in the cities with its habitats. It is understood that the urban environment is shaped by these two factors; however, this paper shall only discuss the influence of natural aspects in urban environment such as climatic, geographic and other natural influences on the settlements.

This paper explores the influence of Persian culture on Iranian cities and concentrates on principles of sustainability as affected by climatic and geographical elements. The aim of this research is to investigate traditional urban settlements of Iran as examples of sustainable urban form and demonstrate how past successful experiences can inspire modern urban planners and designers.

This paper will try to answer questions such as how many great cities were designed and erected in arid region like Iran and how these cities are able to function and live during history and by which ways previous urban designers have solved the climatic and geographical problems.

This sustainable design has been used in past urbanism experiences in Iran in many aspects but in this paper the most important ones will be introduced.

1. Urban structure orientation

Settlement location was selected due to some specific qualities such as connection with major roads, commercial importance, regional centrality, soil conditions, absence of floods, earthquakes and other unexpected disasters and so on.

One of the most basic principles of traditional Iranian urbanism is orientation of the city according to a specific direction which was derived from wind direction, sun exposition, climatic and geographical factors. This specific orientation is called urban ROON in Iranian traditional urbanism vocabulary. There are three different orientations in Iranian cities and it caused these cities to answer all inhabitants' ecological needs and make urban form really sustainable.

In fact ROON is defined as the direction of major public spaces, bazaar and in fact open spaces in a city. For example in the city of Tehran the layout and orientation of houses is northeast-southwest. Urban ROON has been determined according to the direction of floods or favorable winds in the area. Indeed wind towers in Iranian cities were designed and erected faced to the appropriate wind and along the direction of urban ROON.

This direction in Iranian cities has been achieved by use of hexangular geometry. Iranian architects determined three major directions for the cities: Rasteh, Isfahan and Kerman. Cities like Tehran and Tabriz are placed at the direction of north eastern-south western. This direction is almost at the route of Qible.

The suitable direction in some other cities such as Isfahan, Estakhr, Perspolice is northwest-south east. Isfahan is located between Soffe and the Atashgaah mountains and this direction has solved many climatic problems for residents. This rule is still applied for constructing buildings. This direction is exactly shown in Naghshe jahan square. The most famous and well-known architect of Isfahan Ali Akbar solved the incoherent directions of the Qible and urban ROON very wisely (the square as a major public space should follow the urban ROON and also because of religious beliefs all mosques should be erected according to the Qible direction. This great architect has designed a joint between these two important directions and besides creating beautiful scenes in both interior and exterior view, has solved this problem functionally.)

The direction of Kerman ROON is west-east and Kerman, Hamadan and some other cities were constructed according to this direction. In Kerman, mountains extend in north and south. In Hamadan city, because of an unfavorable wind that blows from Abbas Abad valley, this direction is used. One of the most effective factors in selecting this urban ROON in designing cities was the location of them adjacent to one or more mountains. For example Yazd city, placed between two important mountains, is designed according to a mixture of Isfahan and Kerman Urban ROON, one direction follow the blowing of favorable wind from Isfahan and the other is faced the direction of winds that blows from Shirkooh Mountain. These two directions are perpendicular to each other and because of this wind towers look towards two sides. In Tabas city urban ROON is faced against unfavorable wind.

2. Regard to water sources in urban planning

Water as a natural element in urban planning of Iranian cities is considered in many aspects and has always been an essential factor in Iranian towns. Its rarity in an arid country made people respect and treasure it. Indeed Islam holds that water is holy. Iran is a vast country with different geographical zones and water appears in different forms. Water source had an important role in urban design and land use of Iranian cities and I will explain it comprehensively. In this part I mention just some samples of its use and effect in traditional Iranian cities and I divide them into two major groups of man made water sources: Ghanat and Maddi and natural forms such as rivers and springs.

2.1. MAADI

In addition to the Zayandeh River, Isfahan is fed by mountain water carried in canals which meander in profusion through the city. They are invariably lined with trees and provide routes of considerable scenic beauty and water make the environment cool even on the hottest summer days.

Zayandeh River is the most important and also largest river in central Iran. Many important constructions (major factories and power plants) and the second biggest city of Iran (Isfahan) are located along this river. They profited from this river in many different ways. Its water was distributed in different ways. The main traditional way was streamlining, which means that the water of Zayandeh River was distributed from different canals through the entire city and irrigate agricultural and urban fields through these routes. Shortage of water in Isfahan region and the right to use water was a struggling issue in those days. This led to finding new methods and distribution systems. To solve this problem in Isfahan, Sheikh Baha'i, an architect, scientist, philosopher and also a famous poet in the time of Safavid dynasty created a new water distribution system which was named MAADI. According to this watering system the river water is circulated through these canals on specific days, for limited periods.

Figure 1. Aerial photo of Niasarm MAADI and Zayandeh River

From this river five branches are separated to water gardens, palaces, buildings and also farms. These channels are called MAADI in Isfahan dialogue. These canals entered the city in this order:

1. Shah canal: which water was specified for royal palaces and its water volume was half of the Farshadi canal (see 3).

2. Niasarm canal (shown in figure 1): this MAADI is the biggest one in Isfahan and is detached from Zayandeh River next to Marnan bridge and flows to the east part of the city. (See figure 1)

3. Farshadi canal: this canal is detached from the river after Niasarm and its water is one quarter of Niasarm.

4. Fadan canal: the water of this canal is endowed by Safavid king to vow for his health condition. This canal led water towards the government gate after which it was divided into several minor canals.

5. Tiran (Tehran) canal: This canal directs the water to the western part of the city.

Totally, from the source of Zayandeh River to Gavkhooni Marsh 154 MAADIs branch off from this river and run through various villages and cities and irrigate many farms. The word MAADI is derived from Maad dynasty (3000 years ago). In that ancient civilization people would extract water from wells and Qanats and distribute it through canals. The Safavid rulers had noticed that endurance of any garden and green zone in the city depends on water supplies in advance. Regarding this fact and the identification of the concept of region and space and the assistance of Zayandeh River and the slope of the ground, they constructed canals which were detached from the main river and fed all the city buildings and farms through which they solved water shortage problem

Figure 2. Landscape design that occurred next to MAADIs

Apart from the functional role of MAADIs (watering farms, gardens and buildings) along their way through the city, they demonstrate a subtle, brilliant and beautiful scenery and inspire a special and specific typology of architecture around them. They penetrate into the entire city as natural veins. Regarding the traditional architecture and urbanism typology in cities located in desert situations, this natural circulation of MAADIs and green organic routes create an eye catching scene of urbanism and enrich the city with a combination of nature and architecture (see figure 2).

Identification of site and penetration of nature inside it have been defined as two important concepts of relationship between nature and the meaning of space in sustainable design. By adopting these principles and relying on these rules the Government of Safavid dynasty and architects reached a unique urban design in Isfahan which acts as a perfect structure today. I should mention here that Isfahan is a protected World Heritage Site according to UNESCO.

2.2. Qanat

A Qanat or Kareez is a water management system used to provide a reliable supply of water for human settlements and irrigation in hot, arid and semi-arid climates. Qanats are slightly inclined tunnels, at the end of which the water level coincides with the water level at the base of a mountain or foothill. Water flows along the floor of the tunnel until it reaches the ground surface at a location of lower elevation (see fiqure 3).

Vertical shafts extend from the ceiling of the tunnel to the ground surface. These serve the dual purpose during construction of providing ventilation and as an exit for the excavated material. Qanats have been constructed in the Middle East for the past 2500 years. They may be several kilometers long and have been used both for irrigation and municipal water supply. Many are still in use in certain regions of Iran.

The oldest and largest known Qanat is in the Iranian city of Gonabad which after 2700 years still provides drinking and agricultural water to nearly 40,000 people. Its main water well depth is more than 360 meters and its length is 45 kilometers. Yazd, Khorasan and Kerman are zones known for their dependency to an extensive system of Qanat. Each city in these provinces has more than one Qanat.

Fields and gardens are located with a short distance of Qanats' outlet. Water from the Qanats defines both the residental regions and outlying district of the city.

The water is fresher, cleaner, and cooler in the upper parts and more prosperous people live immediately upstream to the outlet. When the Qanat is still below ground level, the water is drawn to the surface via water wells or animal driven wells. Private subterranean reservoirs could supply water for domestic use and garden irrigation as well. Further, airflow produces from Qanat used to cool an underground summer room found in many old houses and buildings.

Downstream of the outlet, the water runs through surface canals called Jubes which run downhill, with lateral branches to carry water to the neighborhoods, gardens and fields. The streets normally run parallel to the Jubes and their lateral branches. As a result, the cities and towns are oriented according to the gradient of the land, which is sometimes viewed as chaotic to the western eye while it was a practical solution for efficient water distribution in different regions.

The lower parts of the canals are less desirable for both residences and agriculture. The water becomes progressively more polluted as it runs downstream.

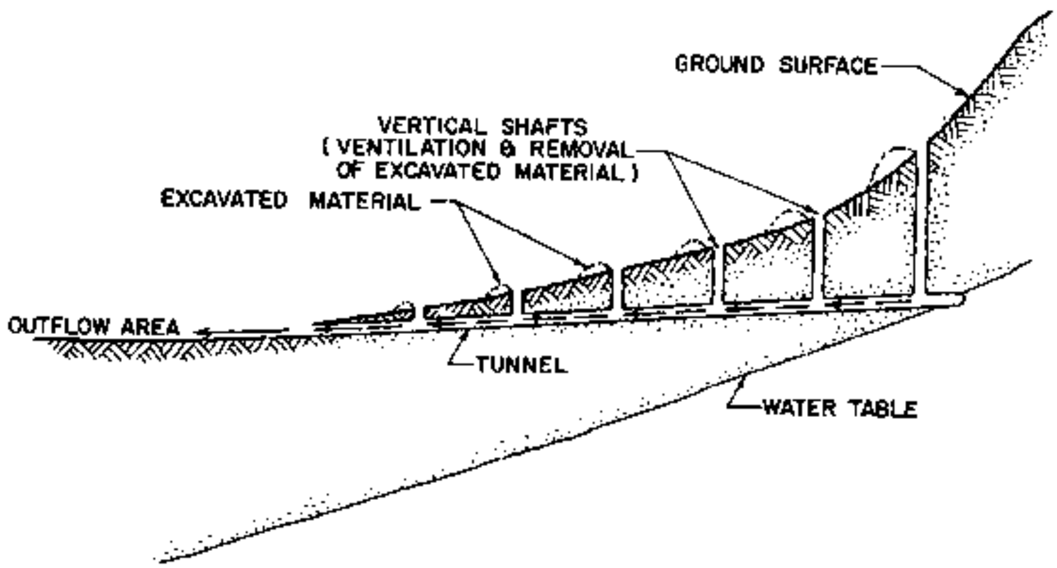


Figure 3. Qanat technology

Qanats were frequently split into an underground distribution network of smaller canals called Kareez when reaching a major city. Like Qanats, these smaller canals were constructed underground to avoid contamination.

The use of Qanat results in the construction of special spaces in cities. Because of the hot weather of desert cities and the absence of any permanent river (most rivers in Iran are seasonal and have traditionally not been able to supply the needs of urban settlements) water is a valuable element for living. That means that in this culture water and access to it is designed as an underground process. Water is delivered under the ground and in some specific spaces people got access to it.

Qanats used in conjunction with a wind tower can provide cooling as well as a water supply. A wind tower is a chimney-like structure positioned above the house to catch the prevailing wind. The tower catches the wind, driving a hot, dry breeze into the house; the flow of the incoming air is then directed across the vertical shaft from the Qanat. The airflow across the vertical shaft opening creates a lower pressure and draws up and mixes with the cool air from the

Qanat tunnel. In dry arid weather this can result in a greater than 15°C reduction in the air temperature coming from the Qanat; the mixed air still feels dry, so the basement is cool and only comfortably moist (not damp). Wind tower and Qanat cooling have been used in hot areas for over 1000 years.

An AB ANBAR is a traditional reservoir of drinking water in Persian antiquity. The Persian phrase literally translates as "water warehouse". AB ANBAR has a long history in Iran, and there are still some remaining today from the 13th century. These reservoirs would be subterranean spaces that were connected to the network of Kareez in the city. A typical residential AB ANBAR was located in the enclosed garden, having the capacity to hold 50 cubic meters. It was filled once every two weeks, and has its inside surfaces cleaned from sediments once a year (called LAYEH RUBI). In order to access the water, one would go through the entrance which would always be open, traverse a stairway and reach the bottom where there would be faucets to let the water in the storage.

Next to the faucet would be a built-in seat or platform, a water drain for disposing water from the faucet, and ventilation shafts. Depending on where the faucets are located, the water would be colder or warmer. Some storage would have multiple faucets located at intervals along the stairway.

Thus nobody had access to the body of water itself, hence minimizing possible contamination. The storage is completely isolated from the outside except for ventilation shafts or wind catchers. To further minimize contamination, the storage tank's interior was scattered with a salty compound that would form a surface on top of the water. The storage tank would then be monitored year round to ensure that the surface would not be disturbed. The water of course would be drawn from the bottom using the PASHIR (see figure 4).

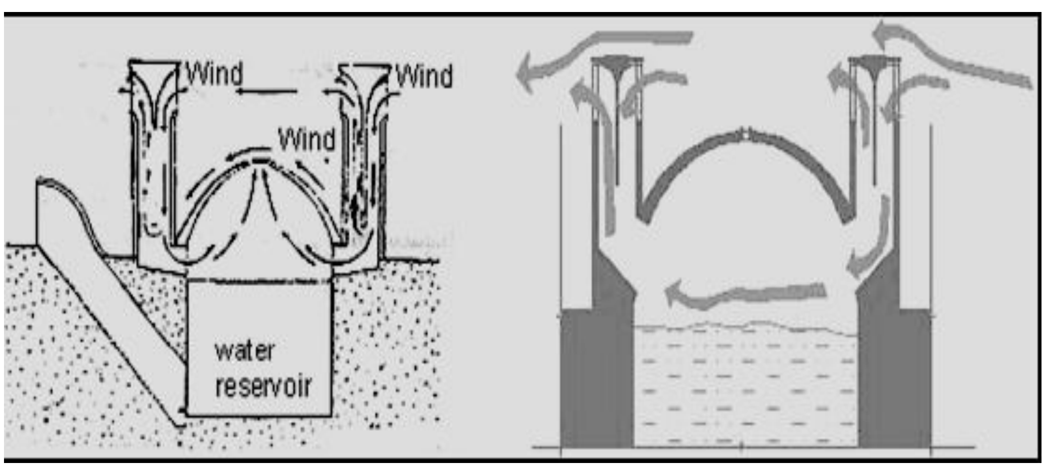


Figure 4.AB ANBAR (water storage) system

Public AB ANBAR was often built wherever demand dictated. But factors such as its accessibility to Qanats, ease of public accessibility, and a homogeneous density of it in each area determined the size and location of an AB ANBAR.

Each Qanat covered a specific neighborhood and often further branched into *sub-kareezes* as they went along serving private and public AB ANBARs. Yet most AB ANBARs were located in adjacent to commercial, religious, or other public places of interest. Many of them had been located at busy intersections. Unfortunately in early 20th century the urban structure of many traditional Iranian cities has changed dramatically. Hence AB ANBARs today seem to be situated out of place.

In Qazvin, which was nicknamed as the city of AB ANBRs, today less than 10 AB ANBARs remain intact from the destructive forces of hasty modern urban development. Of the other 100 that used to be scattered throughout Qazvin, only parts (such as the steps, the entrance, or the storage) remain. Most have been destroyed by housing projects and private developers. In Qazvin, none are functional anymore. However some continue to be used in some areas in rural Yazd and urban Nain.

Table1.Fully intact surviving AB ANBARs of Qazvin in order of capacity

Ab anbar name	Dimensions (m)	Capacity (m^3)
Sardar-e Bozorg	17 x 17 x 17	4900
Jame' Mosque	37.5 x 10 x 10	3750
Nabi Mosque	36 x 10 x 10	3600
Sardar-e Kuchak	20 x 19 x 5.5	2090
Haj Kazem	26 x 7.5 x 10	1950
Hakim	18 x 18 x 6	1944
Agha	11.5 x 10.25 x 5.5	648
Razavi Caravanserai	14.5 x 6.5 x 5	471
Zobideh Khatun	11.5 x 2.65 x 6.5	198

Explosive migratory trends in Iran in the past 30 years have led to a wave of hasty development inside the old quarters of old cities, destroying their original structure.

3. Garden cities

Some of old Iranian cities have been designed as a garden city and this plan was derived from their agricultural and economical role in the region. Consideration of this fact results in social and economical sustainability of traditional Iranian cities.

The main characteristic of these cities was the use of water; it was the ultimate luxury to desert dwellers, who appreciated it not only because it allowed plants to grow but also it cooled the air and pleased the ear with the sound of its movement. Water moves in the middle of main streets and passages and in a warm country like Iran this circulation helps a lot for cooling and decreases the hotness of summer technically and psychologically.

As perfect examples of these garden cities we can name Shiraz and Isfahan. Because of its unique beauty and historic ambiance, Isfahan is called "Half the World" as called for the first time by French poet Renier who visited this city in the 16th century. The most famous Persian description of the city of Isfahan is "*Esfahan Nesf-e Jahan*" which means Isfahan is half of the world and was coined in the 16th century to express the city's grandeur. The history of Isfahan can be traced back to the Paleolithic epoch. During their excavations, archaeologists have succeeded to discover enormous historical artifacts dating back to Paleolithic, Mesolithic, Neolithic, Bronze and Iron ages. Isfahan during Shah Abbas period was designed and erected as a city with various gardens and with full respect to its nature. Isfahan became the capital of Iran by Safavid dynasty from the time of Shah Abbas I (1587-1629), who built numerous fine buildings, some of which still survive. He also set up spacious gardens and avenues and extended the bazaar, for which workmen were forcibly imported from Armenia. The Armenian community has its own quarter across the river.

Shah Abbas selected a wide ground next to the old city and Zayandeh River to construct royal gardens and palaces for the king. Isfahan followed the pattern of Qazvin urban design. A garden city (Baghistan) was created south of the old city center. A large street was built in 1596 to connect the entrance at the Dawlat gate near Shah Abbas urban residence to his great suburban garden to the south. This garden that stood south of the Zayandeh River was known as the Hizarjarib (1000Jarib) garden. A canal dug from the river irrigated the garden and ran through the street that formed the main axis of the new garden city. The Georgian Allahvirdi Khan was commissioned to build a monumental bridge finished in 1602 that connected the two portions of the promenade.

Shah Abbas also drew up the street plan, the layout of the parks and gardens and the construction of royal pavilions scattered about in the greenery. An immense bridge was constructed over Zayandeh River and was considered an extension of the magnificent (1,750 yard) ceremonial avenue known as Chahar Bagh. Chahar Bagh Street (4 Gardens Street) starts from Naghshe Jahan square and ends in several gardens which cover more than ¾ of Isfahan urban area. A wide water canal would run along in the middle of this beautiful street. The water benefits from the natural slope of the region and passes Zayandeh River and reaches 1000 Jarib garden at the end.

This street and several gardens match with Zayandeh River beautifully and by use of this skillful design river becomes an inseparable part of the city and urban life. The combined historic-natural axis of Isfahan is with no doubt the most significant urban structure in Iran that was planned in seventeenth century - in continuation of the organic structure shaped in previous centuries

- and has influenced and guided the growth of the city during the past 400 years (see figure 4).

The historic axis consists of five sections:

1. The bazaar stretching about 2500 meters from Toghchi Gate to Naghsh-e-Jahan Square;
2. The Safavid Court Quarter 500 meters long from Naghsh-e-Jahan Square to the beginning of Chahar Bagh;
3. The Abbasid Chahar Bagh with an approximately 1500 meters length, from Dowlat Gate to the Zayandeh River;
4. Si-o-se-pol Bridge, 400 meter long (over the width of the river, along the axis);
5. Upper Chahar Bagh with 1500 meter length from Zayandeh River to Hezar Jarib Garden

Thus, the length of this man-made axis is totally 6400 meters.

The Second axis consists of the Zayandeh River between historic bridges of Marnan and Shahrestan with an approximate length of 8000 meters and width of 300 meters. For depicting the combined historic-natural axis of Isfahan an area of 340 hectares including 1320 parcels (registered plots) is allocated where over 220 historic buildings with excellent or distinguished values (such as mosques, caravanserais, schools, public baths) as well as several complexes with authentic historic composition are located.

Figure 5. City of Isfahan

The historic site (the result of the two historic and natural axes in perpendicular shape) is the only remaining work of an integrated planning and design scheme in the country's history that, in spite of negligence during the past three centuries, still possesses the potential of self-demonstration in the contemporary city.

Another good example of Iranian garden city is Bam city. Unlike Isfahan that was designed as a garden city by government, Bam is an organic garden city which was designed and shaped by people during a long time. Bam and its surroundings are inscribed as a world heritage sites. Bam is situated in a desert environment on the southern edge of the Iranian high plateau (see figure 5).

The origins of Bam can be traced back to the Achaemenid period (6th to 4th centuries BC). Its prosperity was from the 7th to 11th centuries, being at the crossroads of important trade routes and known for the production of silk and cotton garments. The existence of life in the oasis was based on the underground irrigation canals, the Qanats, of which Bam has preserved some of the earliest evidence in Iran. Arg-e Bam is the most representative example of a fortified medieval town built in vernacular technique using mud layers (*Chineh*).

The city of Bam and its surrounding cultural landscape represent an exceptional testimony to the development of a trading settlement in the desert environment of the Middle Eastern region. The cultural landscape of Bam is an outstanding representation of the interaction of man and nature in a desert environment, using the Qanats. The system is based on a strict social system with precise tasks and responsibilities, which have been maintained in use until the present, but have now become vulnerable to irreversible change.

Figure 6. Bam citadel and garden city

Conclusion:

Some Iranian traditional experiences in urban sustainability are described in this paper. The main aim is to mention the importance of climatic and geographical conditions on formation and design of Iranian cities.

In countries like Iran it is inevitable to establish cities in arid regions. Many new cities have been designed in the current century but most of them could not solve regional problems and respond to inhabitants need. The most important factor in designing a city is to plan it in such a way that it could function and develop during the history.

With attention to the results that are achieved from this quest in urban design experiences of historical Iranian cities and with regard to this fact that old cities are still responding to functional and psychological needs in the best way, it is necessary to learn from these lessons and benefit from appropriate urban structure orientation, site circumstances and natural, regional potentials in designing new cities and also expanding existing cities to enrich urban space and make the cities worth living.

References:

Pirnia, Mohammad Karim, Memari e Islami e Iran (Iranian Islamic architecture) ISBN 964-454-093-x

Strauss, M.J. (2005) Old ways of water management spring up again in arid regions. International Herald Tribune. Aug 20, 2005.

Yavari Minouch, Moghtader M.Reza, (1998) The Persian garden: eshoes of paradise International Persian garden conference press. Tehran, Iran

Afshar Iraj, (1995), Yadegarhaye Yazd (Yazd relic), cultural intellectual press institute, Tehran, Iran

http://whc.unesco.org/en/list

www.earth.google.com.

www.archnet.org

Sustainable mobility and urban planning: the application of the Analytic Network Process for the assessment of different transport scenarios

Dr Marta Bottero, Isabella M. Lami

Politecnico di Torino, Italy

The Analytic Network Process is a multi-criteria measurement theory that is used to derive relative priority scales of absolute numbers from individual judgments. The Analytic Network Process offers a general framework to deal with complex decisions which provides a comparison of the different options.

The paper shows the application of the Analytic Network Process to assess different transport scenarios in the town of Venaria Reale in Northern Italy.

In particular, considering the necessity of improving the connections between the city of Turin and the town of Venaria, the need for new infrastructures emerges. In this sense, it is necessary to investigate different project solutions, taking into account the problems related to sustainable mobility and the impacts on the urban structure that will, from necessity, be changed to a great extent.

The paper illustrates the work that has been done in order to make the decision makers able to consider the different aspects of the problem simultaneously and to find the most suitable solution.

Keywords: Analytic Network Process, complex systems, infrastructural development, sustainability assessment, transport

1 Introduction

From a specifically sector-oriented viewpoint, the rapport between transport and land use can be defined schematically as the relationship between the mobility system, represented by the demand and offer of transport, and activities localised in the territory. This relationship can be seen as a circular process in which activities localised in the territory stimulate a demand for transport, generating or attracting relocations, and the transport systems attract localisations, improving accessibility in certain areas of the territory (Banister and Lichfield 1995). Localisation of activities and persons in the territory is influenced by the related levels of accessibility and may stimulate new demand for transport.

In actual fact, the elements involved in the relationship between transport and land use are much more complex and involve a range of different environments.

In the past, further transport investment in cities has been argued firstly on the basis of how to allocate growth and, subsequently, on the main means to promote economic development and the revitalisation of depressed areas (Banister 1994).

This topic has now been broadened to embrace new aspects, first of all, enhanced awareness of the issue of environmental quality. The need for more fully-articulated intervention on the planning of new transport infrastructures and on traffic is justified by the increase in vehicle atmospheric emissions to be ascribed, in turn, to the higher number of vehicles on the road. This new awareness is also reflected in the greater attention dedicated to social costs in territorial transformation solutions and the works necessary to guarantee accessibility to new settlements.

However the links between transport and urban development are not well known, even in a physical sense. In addition to the physical relationships (e.g. density), there are important economic factors (e.g. rent levels and land prices), social factors (e.g. equity and distributional factors) and environmental factors (e.g. quality of life). In each case, transport has an important influence, which is well accepted at the general level, but at a more detailed level both the methodologies for analysis and the empirical sense is limited (Banister and Lichfield 1995).

The case illustrated in this paper, referring to the improvement of connectivity between Venaria and Turin, provides an opportunity to stress the need for new approaches to such an increasingly broad-scale, complex topic as the relationship between transport and urban development.

This paper proposes adoption of the Analytic Network Process (ANP) multi-criteria technique, able to consider a wide range of quantitative-qualitative criteria, according to a complex model (Saaty 2005).

In this research, based on the study carried out by Siti (2008) to investigate possible transportation solutions to connect Venaria and Turin, the ANP model has been developed on the basis of a literature review, a series of informal discussions with various academics and researchers, and a focus group comprising various experts.

After the introduction, the rest of the paper is organized as follows. First of all, we review literature on transport and urban development. The literature includes: transport-related aspects (accessibility and method of operation); economic aspects (direct costs and valorisation phenomena); lastly, urban and environmental planning aspects (urban form, transport and social costs). In the next part of the paper, we present a methodology for selection of a new transport infrastructure system for the town of Venaria. An ANP-based approach for the final selection is the core of this methodology. We conclude the paper with a discussion and various proposals for improving the method.

2 Transport and urban development: the literature

The literature review is mainly aimed at identifying the criteria that must be considered when selecting a new transportation system to link a small town (Venaria) and a medium-sized city (Turin) which border on each other.

The outcome of the literature review, together with the inputs from the Siti research (2008) and from the experts, has been used to develop an ANP-based model for final selection of the criteria to identify the best system of transport in the case analysed.

2.1 Transport-related aspects: accessibility and method of operation

Urban transportation systems influence urban efficiency by determining the level and intra-urban distribution of accessibility, defined as the ability to visit activity places by using the transportation system at an acceptable cost in terms of time and money (Dijst et al. 2002).

The concept of accessibility can be interpreted in various ways according to whether it is considered from the viewpoint of the individual, who can reach various activity places, or the activities that can be reached by people located in different places (Dijst et al. 2002). In the first case, reference is made to active accessibility and in the second to passive accessibility.

Generally, it can be said that the behaviour of individuals is directed not so much towards an absolute reduction of travel but on more efficient use of people’s total available travel time (Crane 1996; Handy 1992). Therefore, the point of view from which to address the problem is all-round management of people who all seek to optimise something facilitated by ease of movement: social relationships. The urban system is, therefore, a device designed to optimise not so much “travel” as the ratio between travel costs and the quantity and quality of the social interactions made possible by travelling (Orfeuil 2008).

This interpretation has major repercussions on assessing the impact of new functions on mobility conditions (Riganti 2003). First of all, it appears that guaranteeing a high functional mix is not sufficient to shorten travelling time and to reduce induced vehicle traffic. The presence of activities that people could carry out close to where they live must be judged positively as it offers them an opportunity, but does not determine their behaviour (Handy 1992). Also, it cannot be assumed that accessibility to pubblic transport is a decisive factor in influencing personal decisions and can, on its own, reduce vehicle traffic. As has been demonstrated in several cases (Cervero and Landis 1997), accessibility to public transport does not reduce vehicle traffic. The only way to reduce vehicle traffic (if this is the political objective that the administration of a city intends to achieve) is to curb vehicle access by reducing the capacity of the offer, increasing the related cost or reducing the offer of parking.

Considering a public transport system, the concept of accessibility must be viewed in conjunction with availability of the service, which depends on the extent to which the timetable of the service complies with the requirements of demand and, therefore, on scheduling of the service and its frequency (Riganti 2003). Lastly, one of the main factors that affects service quality is the relationship between service capacity and demand, with regard to vehicles and stops, total travelling time from origin to final destination and its reliability (Riganti 2003).

2.2 Economic aspects: direct costs and increase of land and building values

Lastly, we stress that public investment and government of the city is an essential condition for triggering land value creation. In particular, urban lend rent depends to a considerable extent on the presence of a major concentration of social fixed capital infrastructures, often furnished to potential users at zero cost: rail and road transport network nodes, airports, rapid transit surface and underground passenger transport systems; advanced technology telecommunications networks, etc. (Camagni 1993). Lastly, a close relationship exists between the average price of housing and travelling time (at least in large urban agglomerations).

2.3 Urban and environmental planning aspects: urban form, transport and social costs

The way in which settlements in the territory (together with technologies, lifestyles and consumption patterns) are organised is a major factor in determining the impacts of human activities on environmental balance and social costs.

The costs of the various ways in which urban systems grow and are organised in the territory concern and which are insisting on the public at large (Camagni et al 2002):

- public costs of infrastructurisation of the territory;
- public costs for management of public services in the territory: transport services, public lighting, waste collection, etc;
- social costs deriving from negative externalities of individuals' behaviour (for example, in the generation of private traffic differentiated amongst the various types of urban expansion, in the mix of individual and commercial mobility);
- social costs deriving from more or less efficient use of limited public resources (such as land) or more or less efficient use of public resources (public green, transport infrastructures);
- socio-psychological costs of segregation phenomena.

Many international surveys have confirmed the higher cost of a dispersed urbanisation model, highlighting the close inverse relationship between residential density on the one hand and use of private vehicles and consequent per capita energy consumption on the other.

In fact, although per capita energy consumption is a direct indicator of a negative externality and, therefore, of an environmental and collective cost (emissions), it is also a indirect indicator, almost a metaphor, of a set of other externalities linked to use of the automobile: acoustic pollution, aesthetic pollution (particularly evident in the European city, not constructed as a motorised city), the value of the time lost commuting, stress, exclusion (Camagni et al 2002).

These are, perhaps, the major collective costs deriving from a shortage of urban land. On the one hand, the demand for land for mobility and parking of a growing population of vehicles continues to increase; on the other, the slow, difficult expansion of the offer of urban surfaces, due both to problems of cost (underground expansions for infrastructures, parking, activities) and because cities have now reached a size whereby further growth would trigger a strong decline in rents. There is a need for different cities but, in any case, cities in which interaction is possible without the current private, social and mobility costs (Camagni et al, 2002).

3 The Analytic Network Process

3.1 Background and state of the art

The Analytic Hierarchy Process - or AHP (Saaty 1980) – and its more generalized evolution, i.e. the Analytic Network Process – or ANP (Saaty 2005; Saaty and Vargas 2006) play very important roles in multicriteria analyses.

Many decision-making issues cannot be structured hierarchically, because they imply interactions and dependence between the highest elements and the lowest. In fact, not only does the importance of the criteria cause the importance of the alternatives, as in a hierarchy, but also the importance of the alternatives causes the importance of the criteria.

A hierarchy has a linear structure that goes from the top to the bottom, while a network can be distributed along a number of directions, and involves interactions and cycles. The ANP enables one to survey and measure such inter-dependences. It extends the applications of the AHP to cases of interdependent relationships between the assessment elements and generalizes the approach of the super-matrices introduced by the AHP.

The ANP model consists of control hierarchies, clusters and elements, as well as interrelations between elements. The ANP allows interactions and counter-interactions between clusters and supplies a network structure that is able to connect clusters and elements in any manner in order to obtain priority scales from the distribution of the influence between the elements and clusters.

The ANP requires a network structure to represent the problem, as well as a pairwise comparison to establish the relationships within the structure.

The analytical tools provided by ANP are very useful to support the decision making process; nevertheless, it is always very important to supply a great deal of information or many experts to the model in order to arrive at a better solution.

Comprehensive collection of the literature involving AHP can be found at http://www.expertchoice.com. In particular, there are many works in the field on sustainability assessment that involve AHP and physical and environmental planning (Fusco Girard and Nijkamp 2005; Roscelli 2005), the built environment (Brandon and Lombardi, 2005) and regional development (Nijkamp and Vreeker 2000). From the ANP point of view, the literature is quite recent and some publications can be found in strategic policy planning (Ulutas 2005), market and logistics (Agarwal et al. 2006), economics and finance (Niemura and Saaty 2004) and in civil engineering (Piantanakulchai 2005; Neaupane and Piantanakulchai 2006), while research activity on territorial and environmental assessment is still poor (Promentilla et al. 2006; Lombardi et al. 2007; Bottero et al. 2008; Bottero and Mondini 2008; Tuzkaya and Onut 2008).

3.2 Methodology

The model can be divided into four main stages, that are described below:

Step I: Development of the structure of the decision-making process.

First of all, the decision-making structure must be defined through the recognition of its main objective. Such an objective should later be divided into groups ("clusters"), that are made up of various elements ("nodes"), and alternatives or options.

Secondly, the relationships between the different parts of the network must be identified. Each element can be a "source", that is an origin of a path of influence, or a "sink", that is a destination of a path of influences.

There are two possible structures for an ANP model, a "simple" network and a "complex" network:

The "simple" network is a free-modelling approach, which is not supported by any guide or pre-determined structure. It consists of a network which has cycles connecting its components and a loop that connects a component to itself (Figure 1);

The "complex" network or BOCR (Benefits, Opportunities, Costs, Risks) network allows one to simplify the problem structuring by classifying issues in traditional categories of positive and negative aspects (Saaty 2008). The favourable sure concerns are called benefits, while the unfavourable ones are called costs; the uncertain concerns of a decision are the positive opportunities that the decision might create and the negative risks that it can entail. Each of these four concerns utilizes a separate structure for the decision (Figure 2).

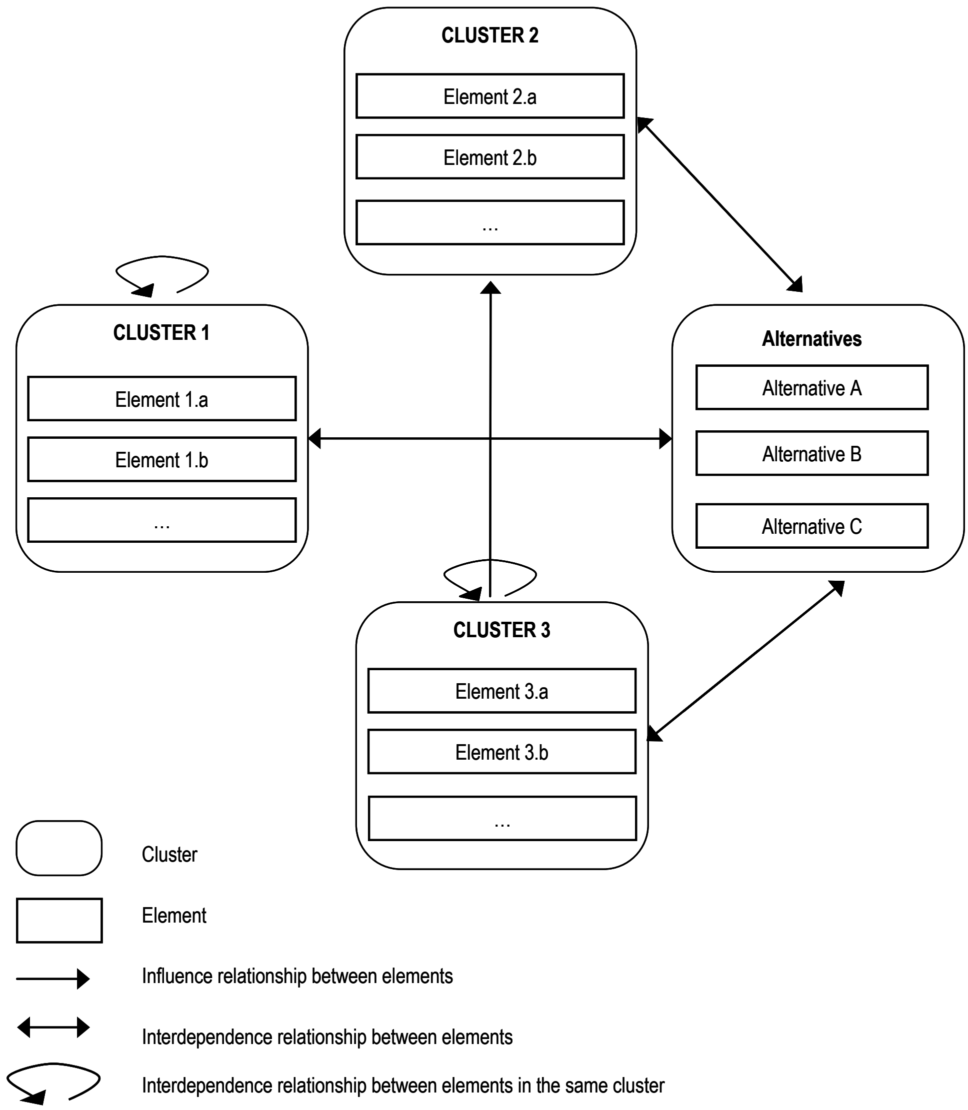


Figure 1: Example of a "simple" network structure with clusters and elements

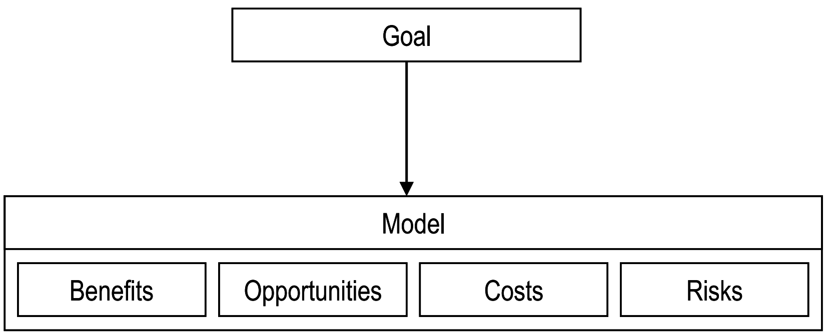


Figure 2: Example of a "complex" network with hierarchy control according to the BOCR model

Step II: Pairwise comparison.

In this step, a series of pairwise comparisons are made to establish the relative importance of the different elements with respect to a certain component of the network. In the case of interdependencies, components with the same level are viewed as controlling components of each other. In pairwise comparisons, a ratio scale of 1-9 is used to compare any two elements (Table 1)

Table 1: Saaty's fundamental scale

Value	**Definition**	**Explanation**
1	Equally important	Two decision elements equally influence the parent decision element.
3	Moderately more important	One decision element is moderately more influential than the other.
5	Much more important	One decision element has more influence than the other.
7	Very much more important	One decision element has significantly more influence over the other.
9	Extremely more important	The difference between influences of the two decision elements is extremely significant.
2, 4, 6, 8	Intermediate judgment values	Judgment values between equally, moderately, much, very much and extremely.

The numerical judgments established at each level of the network make up pair matrices. The weighted priority vector is calculated through pairwise comparisons between the applicable elements. This vector corresponds to the main eigenvector of the comparison matrix (Saaty, 1980)

Step III: Supermatrix formation.

The supermatrix elements allow a resolution to be made of interdependencies that exist among the elements of the system. It is a portioned matrix where each sub-matrix is composed of a set of relationships between and within the levels, as represented by the decision maker's model (Step I). The general form of the supermatrix is described in Figure 3 where CN denotes the Nth cluster, eNn denotes the nth element in the Nth cluster, and Wij is a block matrix that consists of priority weight vectors (w) of the influence of the elements in the ith cluster with respect to the jth cluster. If the ith cluster has no influence on the ith cluster (a case of inner dependence), Wij becomes zero. The supermatrix obtained in this step is called the initial supermatrix.

		C_1				C_2				….	C_N			
		e_{11}	e_{12}	…	e_{1n1}	e_{21}	e_{22}	…	e_{2n2}		e_{N1}	e_{N2}	…	e_{NnN}
C_1	e_{11}													
	e_{12}	W_{11}				W_{12}				…	W_{1N}			
	…													
	e_{1n1}													
C_2	e_{21}													
	e_{22}	W_{21}				W_{22}				…	W_{2N}			
	e_{2n2}													
		…				…				…	…			
C_N	e_{N1}													
	e_{N2}	W_{N1}				W_{N2}				…	W_{NN}			
	e_{NnN}													

Figure 3: General structure of a supermatrix

The eigenvector obtained from a cluster level comparison with respect to the control criterion is applied to the initial supermatrix as a cluster weight. This result is the weighted supermatrix.

Step IV: Final priorities.

In the final step, the weighted supermatrix is made to converge to obtain a long-term stable set of weights. The supermatrix is raised to a limiting power, such as in equation (1), to obtain a matrix where all the columns are identical and each gives the global priority vector:

$$\lim_{k \to \infty} W^k \tag{1}$$

In the case of the complex network, it is necessary to synthesize the outcome of the alternative priorities for each of the BOCR structures in order to obtain their overall synthesis. Different aggregation formulas are available (Saaty, 2006): for example, it is possible to use the marginal formula by forming the ratio BiOi / CiRi for alternative i from each of the four priority vectors.

At the end, we can perform a sensitivity analysis on the final outcome. The sensitivity analysis is concerned with a "what if" kind of question to see if the final answer is stable when the inputs, either judgments or priorities, area changed. It is of special interest to see if these changes modify the order of the alternatives.

4 Application to the study case

4.1 Presentation of the case and description of the alternatives

The case study refers to analysis of the various possibilities of upgrading connectivity between Venaria (around 35,000 inhabitants), renowned worldwide for the presence of the recently-restored Reggia and an international tourist site, and Turin (around 900,000 inhabitants), capital city of Piedmont.

The two towns border on each other but are poorly connected by public transport.

For this reason, the Town Council of Venaria has commissioned a study by Siti intended to identify various solutions able to increase the number of connections, exploring various methods of transport, with also an urban "redesign" connotation.

Many possibilities exist for upgrading transportation: these have been combined in various ways to produce the 4 alternatives considered in applying ANP, as illustrated in Table 2.

Table 2: Methods of transport for upgrading the link between Turin and Venaria (Source: Siti 2008)

Method of transport	**Characteristics**
Hypothesis of a new Turin-Ceres railway layout in the Turin-Venaria stretch	Partial use of the existing line, creation of a new section laid underground to pass under the freeway to the airport and link with the new Rebaudengo station in Turin
Hypothesis of a tram-train service in the Turin-Venaria stretch	The tram-train is a system of transport based on tramway-derived vehicles able to travel both on urban tramlines and on railway lines, in this latter case, jointly with trains, to offer a capillary distribution service inside distant city centres.
Hypothesis of using magnetically-guided vehicles	This is a bus with the advantages of a tramway system; it requires an only 3.40 m lane if one-way and a 6.50 m lane if two-way, but has the advantage of the low investment costs of the bus lines. These vehicles feature all-wheel steering for improved manoeuvrability compared with normal vehicles and can therefore also be used in the historical areas of the city. These vehicles are diesel or diesel-electric powered. This system offers many advantages; magnetic driving means they are able to travel automatically at 70 km/h in all weather conditions; the vehicle has a high level of stability when travelling and improved precision when drawing up to bus-stop landing pads.
Hypothesis of a new rail link between Turin and Venaria	Extension of the existing tram line 3 with North terminal currently on the border of the Municipality of Turin, creating a new branch with terminal at Venaria

	close to the Reggia.

4.2 The ANP-based approach

A very important role is played by the ANP in a territorial transformation process (characterized by a long term nature), where different actors are associated in a dynamic context, some indefinite spaces are left that will be negotiated according to future evaluations and an attempt is made to mediate between opposing positions that can change during the decision process. This evaluation method allows different objectives, interconnected between them and with different units of measure, to be compared; furthermore, the analysis makes it possible to identify new definitions of the problem (Bottero et al. 2008).

In the selection of a new transport infrastructure system, the criteria are of both subjective and objective types. These criteria also have some interdependencies, which can be captured by the innovative ANP multicriteria method.

The network structure of ANP makes it possible to model various selection criteria without concern about what comes first and what comes next. This mode of representing the problem, with less constrains than the structure imposed by the AHP, is more similar to real situations where the elements act in a non-hierarchical way.

This aspect is particularly important in the application of the ANP proposed in this paper. The ANP is not used as a method to determine a priority list of the different alternatives in the decision problem, but as a structured procedure that is able to support the analysis in the identification of the principal aspects to consider in order to come to a decision.

In fact, in this case, the ANP model has been partially applied, as far as the development at the cluster levels is considered, but the evaluation at the element levels has not been studied in depth.

This choice comes from considering that the problem under examination is related to a strategic decision phase, which lacks in detailed information from the point of view of the considered alternatives and the elements at play (for example, the investment cost of the four options are not well defined or the eventual problems related to a particular transport technology are still unknown).

For this reason the ANP model has not been applied to select one of the four options, but has been used with the objective of studying the problem in depth, while trying to identify the most important factors.

4.3 Structure of the BOCR model

A complex ANP model has been developed in order to take into account the complexity of the decision problem.

According to the literature review (paragraph 2), the decision problem has been divided into six clusters (technical – infrastructural aspects, environmental aspects, economic aspects, running conditions, urban planning aspects and social aspects) that have been organized according to the BOCR model. The general objective of the evaluation is the identification of the best scenario for the transport system of the town of Venaria.

Each decision problem is characterized by positive and negative aspects that can emerge in different temporal phases; in this ANP model, the benefits and the costs have been considered, respectively, as positive and negative aspects of the transformation at the present time, while the opportunities and the risks have been considered, respectively, as positive and negative aspects of the transformation in the future scenario.

Table 3 represents the ANP model according to the BOCR model. The network is made up of four subnets with different clusters and elements, as well as the common cluster of the alternatives.

Table 3: Decision network of the problem

BOCR	**Cluster**	**Elements**
BENEFITS	Environmental aspects	Improvement in energy efficiency
		Reduction in traffic emissions
		Reduction in acoustic emissions
	Economic aspects	Valorisation of local commercial system
		Presence of funding
	Running conditions	Increase in frequency of public transport
		Increase in connectivity between different municipalities
		Traffic reduction
	Urban planning aspects	Significance of the project for the urban transformation
		Synergies with the transformations of the Venaria Palace
	Social aspects	Improvement in services for the resident population
		Improvement in services for tourists

		Adhesion to local community expectations
OPPORTUNITIES	Technical-infrastructural aspects	Innovation in transport and communication means
	Environmental aspects	Improvement in acoustic quality
		Improvement in air quality
	Economic aspects	Possible valorisation of the neighbouring areas
	Running conditions	Improvement in the quality of the transport services
		Reduction in journey duration
		Increase in the capacity of the transport of people
	Urban planning aspects	Revitalization of the area
		Development of a new residential area in the town of Venaria
		Change in the image of the town of Venaria
COSTS	Technical-infrastructural aspects	Difference in the level of the railway lines
		Inefficiency of the Torino transport system
		Bend radius of the railway lines
		Gauge between tramway line and railway line
	Economic aspects	Operating and maintenance costs
		Investment costs
		Duration of construction works
	Environmental aspects	Negative impacts of the construction works (noise, vibrations, air emissions)
RISKS	Economic aspects	Lean investment profitability
	Environmental	Negative impacts of to running phase

	aspects	(noise, vibrations, air emissions)
		Visual impact

4.4 Development of the model

In this case, the development of the model consists solely of the cluster comparison phase. In fact, as already mentioned, the objective of the performed analysis is not to succeed in finding the best alternative solution for the transport system of the town of Venaria but to identify the principal aspects related to the decision problem and to measure their importance. It is necessary to highlight that this choice is related to the absence of detailed information about the different alternatives, which made their comparison at the element level impossible.

The cluster comparison of the four subnets of the model was developed by a specific focus group where experts in the different subjects worked together in the compilation of the pairwise comparison matrices. The analysis was performed through the use of the software Superdecision (http://www.superdecisions.com/).

In order to simplify the explanation, the model is only illustrated with reference to the Opportunities subnet. The application is the same for the other subnets (Benefits, Costs and Risks) of the network under examination.

As previously described, the Opportunities subnet is made up of technical – infrastructural, economic, running condition and urban planning aspects (Figure 4).

The technical-infrastructural aspects refer to the innovation in the transport system due to the new communication infrastructures; the economic aspects are related to the increase in the economic value of the area involved in the project; the environmental aspects refer to the improvement in the environmental quality caused by the reduction in traffic; the aspects related to running conditions refer to the improvement in the quality of the transport services; the urban planning aspects are associated to the revitalization of the project area and to the improvement in the image of the town of Venaria.

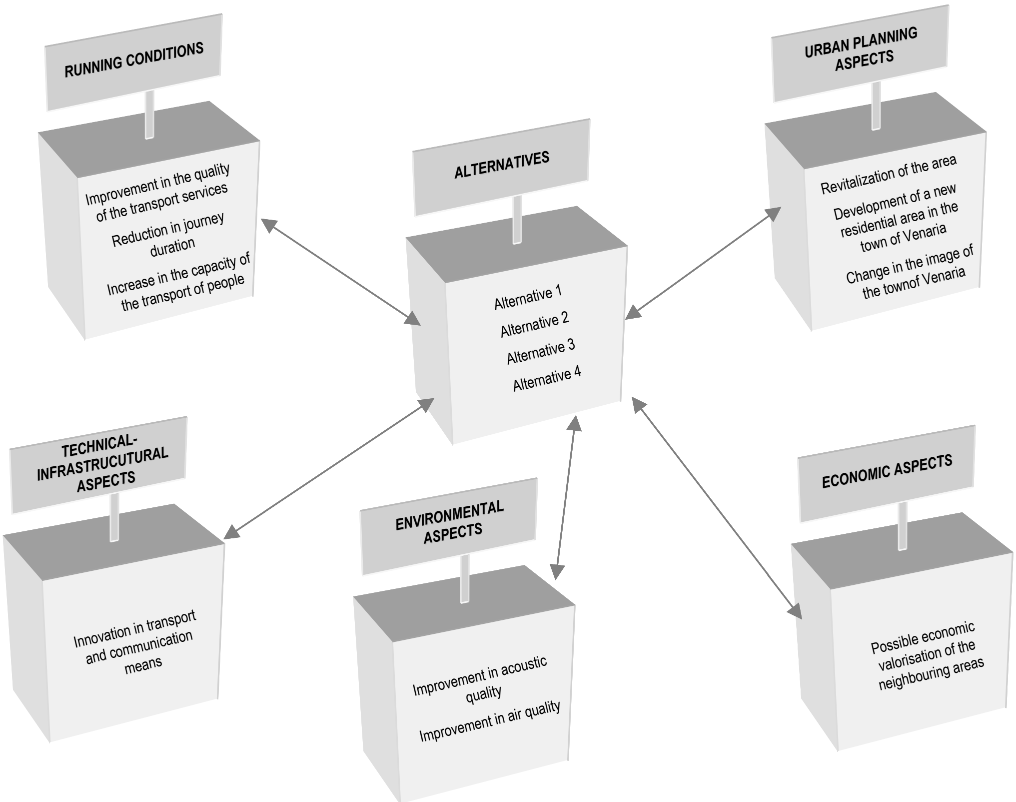


Figure 4: Opportunities subnet

Once that the network has been established, it is necessary to develop the pairwise comparisons at the cluster level.

Considering the cluster of the alternatives as the parent node, the questions that must be solved to compile the matrix are the following:

- With reference to the identification of the best scenario for the transport system of the town of Venaria, given the environmental aspects and the economic aspects, which element is more important and how much more important is it?

Environmental aspects	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Economic aspects

… given the environmental aspects and the technical-infrastructural aspects, which element is more important and how much more important is it ?

Environmental asp.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Techn.-infrastr. a

… given the environmental aspects and the urban planning aspects, which element is more important and how much more important is it ?

Environmental asp.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Urban planning a.

… given the environmental aspects and the running conditions, which element is more important and how much more important is it ?

Environmental asp.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	**7**	8	9	Running conditions

… given the economic aspects and the technical-infrastructural aspects, which element is more important and how much more important is it ?

Economic aspects	**9**	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Techn.-infrastr. a .

… given the economic aspects and the urban planning aspects, which element is more important and how much more important is it ?

Economic aspects	9	8	7	6	5	4	3	2	1	2	3	4	5	6	**7**	8	9	Urban planning .

… given the economic aspects and the running conditions, which element is more important and how much more important is it ?

Economic aspects	9	8	7	6	5	4	3	2	1	2	3	4	5	6	**7**	8	9	Running conditions.

… given the technical-infrastructural aspects and urban planning aspects, which element is more important and how much more important is it ?

Techn.-infrastr. a.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	**9**	Urban planning a..

… given the technical-infrastructural aspects and the running conditions, which element is more important and how much more important is it ?

Techn.-infrastr. a.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	**9**	Running conditions .

… given the urban planning aspects and the running conditions, which element is more important and how much more important is it ?

Urban planning a.	9	8	7	6	5	4	**3**	2	1	2	3	4	5	6	7	8	9	Running conditions .

The judgments established have been used to fill in the comparison matrix (Table 4). According to the ANP methodology, the final priority vectors that result from the comparison matrix in Table 4 determine the first column of the matrix that contains the cluster weights from the point of view of the alternatives (Table 5).

Table 4: Cluster pairwise comparison matrix (Opportunities subnet)

	Alt.	Techn.-infrastr. aspects	Env. aspects	Econ. aspects	Running conditions	Urban planning aspects
Alt.	0	0	0	0	0	0
Techn.-infrastr. aspects	0	1	1/5	1/9	1/9	1/9
Env. aspects	0	5	1	1/5	1/7	5
Econ. aspects	0	9	5	1	1/7	1/7
Running conditions	0	9	7	7	1	1/3
Urban planning aspects	0	9	1/5	7	3	1

Table 5: Cluster matrix (Opportunities subnet)

	Alt.	Techn.-infrastr. aspects	Env. aspects	Econ. aspects	Running conditions	Urban planning aspects
Alt.	0.00	1.00	1.00	1.00	1.00	1.00

Techn.-infrastr. aspects	0.02	0.00	0.00	0.00	0.00	0.00
Env. aspects	0.20	0.00	0.00	0.00	0.00	0.00
Econ. aspects	0.15	0.00	0.00	0.00	0.00	0.00
Running conditions	0.34	0.00	0.00	0.00	0.00	0.00
Urban planning aspects	0.29	0.00	0.00	0.00	0.00	0.00

4.5 Final results

The development of the pairwise comparisons at the cluster level for all the subnets of the model determines the cluster matrices of the analysis.

As already seen for the Opportunity subnet, the first column of the cluster matrix contains the cluster weights of the related subnet.

Table 6 and Figure 5 show the weights of the considered clusters, according to the BOCR model.

Table 6: Cluster weights in the BOCR model

Clusters	B	O	C	R
Technical-infrastructural aspects	/	0,02	0,17	/
Environmental aspects	0,03	0,20	0,04	0,17
Economic aspects	0,52	0,15	0,79	0,83
Running conditions	0,16	0,34	/	/
Urban planning aspects	0,06	0,29	/	/
Social aspects	0,23	/	/	/

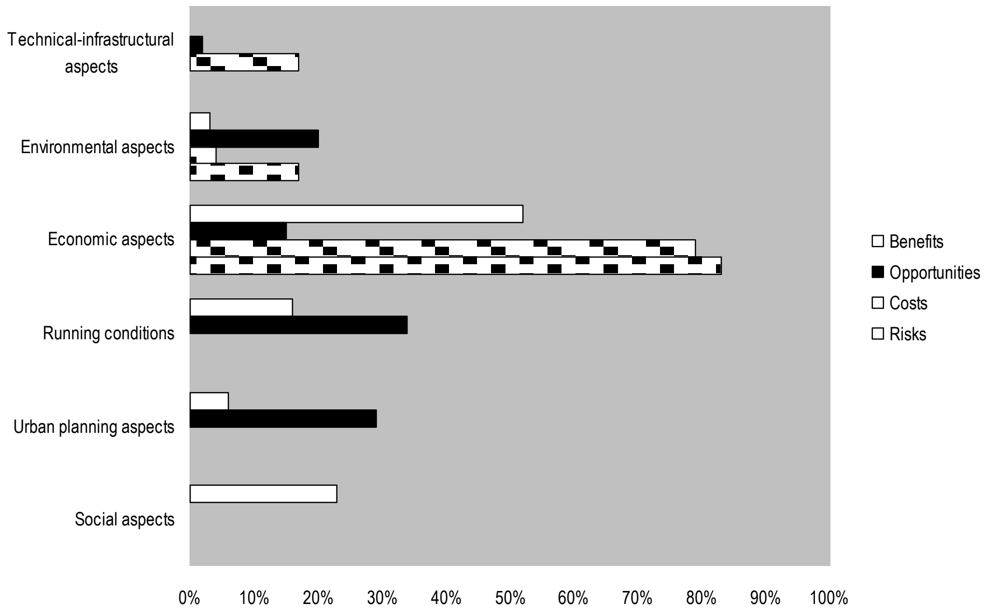


Figure 5: Distribution of the relevance of the considered aspects according to the BOCR model

From an examination of the results, two interesting topics can be observed.

To start with, the most relevant aspects concerning the decision problem are related to the economic aspects. In three of the four considered subnets (Benefits, Costs and Risks), the economic aspects are in the first position in the cluster priority vector, with a weight equal to 52% for the Benefits subnet, 79% for the Costs subnet and 83% for the Risks subnet (Figure 5). It is necessary to underline that these factors are not so decisive for the positive aspects of the transformation (taking into account, for example, the possible economic valorisation of the area) as for its negative aspects (considering, for example, the high investment costs or the risk of lean profitability of the operation).

Secondly, it is possible to stress that the most interesting opportunities that arise from the analysis are related to the running conditions for the new transport connections, which will contribute to an improvement in the services for the population.

These reflections lead to consider the economic aspects and the running conditions as the most important criteria that have to be carefully considered in the subsequent transformation project phases. Although the obtained results could be taken for granted, it is important to point out that the importance of the economic and running conditions criteria emerge from a discussion that was developed among technical experts. The most interesting aspects for the politic decision makers (and probably the real motivations for the transformation) do not in fact transpire from the performed analysis.

5 Conclusions

The paper illustrates the study of different scenarios for the transport connections from the town of Venaria, which is part of the Turin metropolitan area (Italy).

The analysis of the alternative solutions has been performed through the Analytic Network Process. The technique was not developed to select one of the four options, but it was used with the objective of studying the problem in depth, while trying to identify the most important factors.

Through the application of the BOCR complex network and the development of the evaluation at the clusters level, it has been possible to structure the decision problem, in order to identify the benefits, the opportunities, the costs and the risks of the transformation, and to determine the most relevant criteria that should be considered. The results can be used in the future for the definition and the specification of the alternative projects in the subsequent phases of the operation.

This result would appear significant in an urban context currently characterised by a fast pace of change, where instruments to establish the priorities of the criteria, essential for subsequent suitable identification of transformation scenarios, are becoming ever more important. According to Friedman (1987), to intervene in the processes of change and facilitate these, the planner should rely on a solid transformation theory whose requirements are: a) an expressive language able to reach ordinary people; b) comprehensiveness as regards the main variables for transformation of the system; c) a formulation that facilitates adaptation of the general type theory to the "specific" situation. From this point of view, we consider that use of ANP as a sort of structured SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) may provide an excellent contribution to understanding the variables involved in an urban transformation process (Kotler 1988; Wheelen and Hunger 1995; Kurttila 2000).

The model developed here has made it possible to draft criteria able to (Balducci, 1991):

- promote innovation in identifying solutions in situations characterised by uncertainty regarding the methods to be adopted to achieve shared objectives;
- facilitate mediation between contrasting definitions of the objectives of the planning action;
- facilitate the restatement of complex problems;
- steer attention to neglected aspects of planning problems, to show possible action alternatives, to highlight the probable consequences of the actions to be undertaken on the various social groups.

The conclusions are clear but, however, emerge from not perfectly homogenous and therefore only partially reliable data; despite their scientific vulnerability, we have decided to present these in order to stimulate discussion of a potentially fertile source for the evaluation of urban transformations.

6 References

Agarwal, A, Shankar, R, Tiwari, M K (2006), Modelling the metrics of lean, agile and leagile supply chain: an ANP-based approach, 'European Journal of Operational Research', volume 173, 211-225.

Balducci, A (1991), Disegnare il futuro, Il Mulino, Bologna.

Banister, D, Lichfield, N (1995), The key Issues in Transport and Urban Development. In: Banister, D (ed.), "Transport and Urban Development", London: E & FN Spon.

Banister, D (1994), "Transport Planning", London: E & FN Spon.

Bottero, M, Lami, I M, Lombardi, P (2008), "Analytic Network Process. La valutazione di scenari di trasformazione urbana e territoriale", Firenze: Alinea.

Bottero, M, Mondini, G (2008), An appraisal of analytic network process and its role in sustainability assessment in Northern Italy, 'International Journal of Management of Environmental Quality', volume 19, issue 6, 642- 660.

Camagni, R, Gibelli, M C, Rigamonti, P (2002), "I costi collettivi della città dispersa", Firenze: Alinea.

Camagni, R (1993), "Principi di economia urbana e territoriale", Roma: Carocci.

Cervero, R, Landis J D (1997),Twenty years of the Bay Area Rapid Transit system: Land use and development impacts, 'Transportation Research' , volume 31A, issue 4, 309-333.

Crane, R (1996), Cars and Drivers in the New Suburbs, Linking Access to Travel in Neotraditional Planning, 'APA Journal', volume 62, issue 1, 51-65.

Dijst, M, Jayet, H, Thomas, I (2002), Transportation and Urban Performance: Accessibility, Daily Mobility and Location of Households and Facilities. In: Dijst, M, Schenkel, W, Thomas, I. (eds.), "Governing Cities on the Move", Aldershot: Ashgate.

Friedman, J (1987), "Planning in the Public Domain. From Knowledge to Action", Princeton: Princeton University Press.

Handy, S L (1992), Regional versus Local Accessibility, 'Built Environment', volume 18, issue 4, 253-267.

Kotler, P (1988), "Marketing Management: Analysis, Planning, Implementation and Control", London: Prentice-Hall International Edition.

Kurttilaa, M, Mauno Pesonena, U, Kangasb, J, Kajanusa, M (2000), Utilizing the analytic hierarchy process (AHP) in SWOT analysis - a hybrid method and its application to a forest-certification case, 'Forest Policy and Economics', volume 1, 41-52.

Lami, I M, Staffelbach, L (2008), Evaluating the urban redevelopment of railway sites: Zurich Central Station and surrounding areas, In: Third Kuhmo-Nectar Conference - Transport and Urban Economics, 3-4 July 2008, Amsterdam, The Netherlands.

Lombardi, P, Lami, I M, Bottero, M, Grasso, C (2007), Application of the Analytic Network Process and the Multi-modal framework to an urban upgrading case study. In: International Conference on Whole Life Urban Sustainability and its Assessment, 27-29 June 2007, Glasgow, UK.

Neaupane, K M, Piantanakulchai, M (2006), Analytic network process model for landslide hazard zonation, 'Engineering Geology', volume 85, 281-294.

Niemura, M P, Saaty, T L (2004), An analytic network process model for financial-crisis forecasting, 'International Journal of Forecasting', volume 20, issue 4, 573-587.

Nijkamp, P, Rietveld, P, Voogd, H (1990), "Multicriteria evaluation in physical planning", Amsterdam: Elsevier.

Nijkamp, P, Vreeker, R (2000), Sustanability assessment of development scenarios: methodology and application to Thailand, 'Ecological Economics', volume 33, 7-27.

Orfeuil, J P (2008), "Mobilités urbaines, l'âge des possibles", Paris: Carnets de l'info.

Piantanakulchai, M (2005); Analytic network process model for highway corridor planning. In: Proceeding of the International Symposium on the Analytic Hierarchy Process, 8-10 July 2005, Honolulu, Hawaii, USA.

Promentilla, M A B, Furuichi, T, Ishii, K, Tanikawa, N (2006), Evaluation of remedial countermeasures using the analytic network process, 'Waste Management', volume 26, issue 12, 1410-1421.

Riganti, P (2003), "Trasformazione urbana e mobilità", Milano: FrancoAngeli.

Roscelli, R (ed.) (2005), "Misurare nell'incertezza", Torino: Celid.

Roy, B, Bouyssou, D (1995), "Aide multicritére à la décision: méthodes et cas", Paris: Economica.

Saaty, T L (2008), "The Encyclicon: A Dictionary of Applications of Decision Making with Dependence and Feedback Based on the Analytic Network Process", Pittsburgh: RWS Publications.

Saaty, T L (2005), "Theory and Applications of the Analytic Network Process", Pittsburgh: RWS Publications.

Saaty, T L (1980), "The Analytic Hierarchy Process", New York: McGraw Hill,.

Saaty, T L, Vargas, L G (2006), "Decision Making with the Analytic Network Process", New York: Springer Science.

Siti - Higher Institute on Innovation Territorial Systems (2008), "Transport connections between Venaria and Turin: state of the art and preliminary proposals", Working paper.

Ulutas, B H (2005), Determination of the appropriate energy policy for Turkey, 'Energy', volume 30, issue 7, 1146-1161.

Tuzkaya, U, Onut, S (2008), A fuzzy analytic network process based approach to transportation-mode selection between Turkey and Germany: A case study, 'Information Sciences', volume 178, issue 15, 3132-3145.

Wheelen, T L, Hunger, J D (1995), "Strategic Management and Business Policy", Redwood city: Addison Wesley.

Design, regeneration and quality of life

Iain Reid[1], Prof. David Harrison[1], Bruce Wood[1], Dr Michael Clements[2]

1 – Glasgow Caledonian University, UK

2 – Staffordshire University, UK

The quality of life in the urban environment is inextricably linked to social wellbeing and civic pride. When urban areas experience regeneration these issues take on even greater importance and significance with regard to the sustainability of the regenerated area. This paper will show and explore the relationship between quality of life, social wellbeing and civic pride and explain how quality design and design thinking in the urban environment can help areas become successful and sustainable examples of urban regeneration.

It has been suggested that defectively designed urban environments which are poorly implemented contribute to and can be directly related to a poor quality of social life. Elkin, McLaren and Hillman (1991) declare that cities require a built environment which promotes social interaction while simultaneously deterring vandalism and other petty crime and that poor urban design contributes to an adverse social life. It has been argued that bad design facilitates crime and that there is without doubt a direct correlation between the types of urban design implemented in a place and the amount of crime that occurs.

Good implementation of urban design can reduce instances of crime by refusing to provide an environment for it (Hay, 2007). This suggests that certain instances of petty crime are manifestations of discontent with a poorly designed urban environment and opportunist crime in an environment which provides the possibility for such behaviour.

Another example of how design can affect the quality of life is in community interaction. Public spaces cannot be undervalued and, if implemented correctly, can significantly help social cohesion in an area. The improvement of public places can have a significant impact on the conditions of life within communities and can instil a sense of civic pride in residents and convey a much improved social image to visitors to the area (Madanipour, 2004). Making residents of a place feel part of the community is of great importance to the social cohesion of a place and, in turn, this has an affect on the quality of life for all in the community.

The same can be said of the buildings which shape our urban environment; a building which is for the community, like a school, should be part of the community in a visual and symbolic sense. That is to say that if the street is representational of the community in the sense that it is shared public realm then the community buildings, in this case a school, should be part of the street physically in order to be part of the community symbolically (Mackay, 2008).

These examples show that there is an opportunity for creative thinking to assist in the design of urban environments which improve quality of life in urban development and regeneration delivering sustainable results for communities. Using further examples from research and first hand interviews, this paper will explain and explore the possibilities available in design-led development and regeneration and the positive impacts on quality of life in the urban environment which can come from this approach.

Keywords: communities, community sustainability, creative society, design process, environmental quality, social inclusion, urban design, urban regeneration, urban sustainability

1 Introduction

Public space is used by all on a daily basis. The environment in which people live is a pivotal aspect of daily life. Therefore, the urban environment can have a significant impact on the quality of life for the communities living in these areas. Environments within towns and cities which have experienced the effects of industrial decline are therefore a crucial part of the regeneration of such towns and cities.

In urban environments which have suffered from the effects of industrial decline there are many issues which require attention if regeneration of the area is to have a positive and significant impact. The problems we associate with the decline of industry in a city or area are the physical deterioration of the urban fabric, the economic effects of increased unemployment and the social effects associated with such hardship within communities. Urban regeneration sets out to address the physical, economic and social issues associated with the decline of industry.

The gentrification of urban areas, particularly those which have suffered in the wake of industrial decline, serves to exclude the less affluent communities and businesses which, in a sense, "belong" to the area and give it character, distinctiveness and identity. This paper will identify ways of regenerating such urban areas which can provide a place which benefits environmentally, economically and socially, thus allowing places to renew and improve quality of life while retaining a sense of heritage and distinctiveness as well as a rich social and cultural mix.

In this paper, specific reference will be made to the experience in the UK. As the host cities of this research, there is particular interest in the experiences of Glasgow and Stoke-On-Trent. The research findings are primarily aimed at these cities but it is hoped these findings could be applied in a wider sense out with the host cities. Both Glasgow and Stoke-On-Trent have their own vision for regeneration but their experiences so far, which will be explored further, have been quite different. The paper will highlight the importance of design in regeneration and indicate the positive impact that design thinking can have.

2 Regeneration

It has been said that regeneration as we know it can be viewed as a response to the industrial decline of the 1970s and 1980s which was catalysed by the oil crisis of 1973. Couch, Fraser and Percy (2003) state that the regeneration we deal with in the 21st century is unique to the last 25 – 35 years. Although they concede that rebuilding and renewal projects such as Baron Haussmann's re-thinking of urban Paris in the mid to late 19th century and the reconstruction of London in the wake of the Great Fire of 1666 can be described as regeneration, Couch, Fraser and Percy (2003) add that recent decades have dealt with bigger and more complex problems and, thus, are different to the projects mentioned in Paris and London. Lozano (1990) cites the rate of change in cities today as a major factor in differentiating them from those of the past. The definition in this research is that regeneration is a response to the problems associated with the decline of industry.

In places which experienced industrial decline, Local Authorities were placed under tremendous economic strain. No longer do the cities flourish as the financial weight of unemployment and declining profits intensifies. Cutbacks in public expenditure and services stem from these circumstances leading to physical decay in the urban environment and social problems arise from the inevitable growth of urban deprivation. It is from this all too familiar scenario that regeneration has a part to play in attempting to reverse the social, economic and physical urban regression that mirrors industrial decline.

It is true that a local economic boost is a very positive and important aspect of urban regeneration. Data collected by the authors suggests that 74% of citizens see a local economic boost as an important factor in regeneration. Research carried out by the Scottish Executive (2006a) into the influence and effect of architecture and design on the economy and the environment suggests that "visionary buildings do indeed improve the standard of living by creating jobs, helping to recruit and retain staff and increasing property prices in the surrounding area. The findings of this publication also put forward that buildings with character and a "wow" factor are taken into consideration when important location decisions are made by large companies and businesses.

However, attracting this kind of affluence to an area has its consequences in the displacement of less affluent inhabitants and local businesses (Hackworth, 2002). This in turn serves to increase the homogenisation of such areas which now not only have a uninspired and derivative urban fabric but a community which excludes the cities lower earners and houses only the multinational businesses which can afford to be there. It seems that many places seeking to regenerate forget about the less affluent or simply ignore their needs.

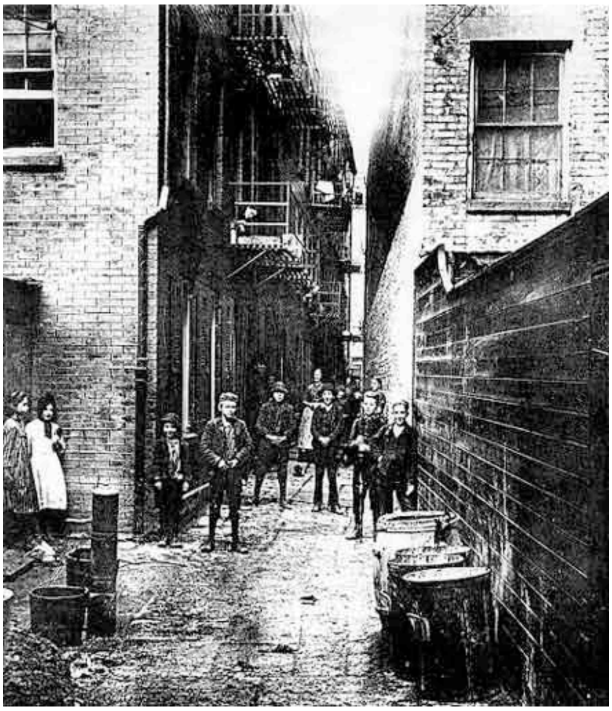


Figure 1: Old inner city slums

This is something touched upon by Jane Jacobs (1961) over 40 years ago. Jacobs' description of the slums (Figure 1) as "vicious circles" rings true when talking today of gentrification. By gentrifying areas and making them less financially accessible for the less affluent, development policy only serves to displace those communities who stand to benefit from regeneration at a social level.

Jacobs has great sympathy for those displaced in the redevelopment of the problematic old inner city public housing districts and asserts that moving these communities to peripheral high-rise housing schemes did not address and eradicate the associated problems. It became apparent that this particular urban policy had merely moved these social concerns to another location. Justifiably, Jacobs refers to the slum communities as "victims". Roberts and Sykes (2000) also assert this, observing that the Government's priority in the 1950s focused on clearing the public housing districts with high-rise housing implemented as the solution. This "solution" provided neither a socially constructive environment nor did it attempt to address the social issues associated with the slum communities. The problems were not solved, only moved elsewhere.

The same can be said of developments which have financial gain as their primary focus. When developers, planners and local authorities visualise a place in such a way as to gain solely economically it only serves to accelerate the process of gentrification. This approach fails to address the critical social issues which affect communities and acts to exclude the less affluent citizens and businesses which not only belong to these areas but give them distinctiveness. This results in the production of a new urban environment for progressively more wealthy consumers, companies and inhabitants. It is the case that the regeneration of cities must strive to improve the local economy. However, with such aspirations it is important to bear in mind the negative consequences of gentrification and the displacement of communities.

It has been said that what is referred to as "regeneration" is key to politics today. Businesses and multinational corporations seem to be consistent beneficiaries of regeneration and with gentrification and social displacement occurring in regeneration practice there seems to be some justification in questioning the "real" driver behind such projects (Collins, 2007). Certainly the use of "regeneration" as a phrase in discourse and official documents seems to lend credibility to projects which might otherwise be challenged, such as the recent and well documented prospect of a "Supercasino" in the UK which resulted in bids from several major cities and was awarded to Manchester. In such a venture it easy to see where the economic balance can be rectified, however the positive social effect in communities of regeneration driven by the economy in projects such as "Supercasinos" is highly debatable.

The example of Atlantic City in the USA exemplifies this scepticism. The economic boost to the area has had little effect on the social problems in the area. Since the opening of the first casino in 1978 the city has been transformed economically. Thousands of jobs have been created and the city has strengthened its status as a tourist destination. However the social problems which existed prior to 1978, including crime and drug problems, still exist and the divide between the privileged and the less fortunate has been intensified (Evans, 2008).

This is why it is important that communities are at the forefront of the plans to regenerate areas of our cities and towns. If the social issues are not addressed in these areas then the venture will not have combated all of the problems arising from industrial decline.

3 Issues to Address

In the UK, Glasgow and Stoke-on-Trent (Figure1) have significant social problems which can be indicated by the levels of deprivation, unemployment, ill health and related matters in each city. Studies show that Stoke-On-Trent was ranked the 2nd most deprived city in the West Midlands (City of Stoke-On-Trent Council, 2007). 19% of the working age population of the city receive out of work benefits compared to the regional average of 13% and nearly 20% of the working age population have no qualifications. In addition, crime levels are higher in Stoke-

On-Trent than the regional average with 14.9 notable offences per 100 people (West Midlands Regional Observatory, 2008). Life expectancy for a male in the city is 73.2 ranking it 371st from 374 local authorities in England and Wales (City of Stoke-On-Trent Council, 2006).

Figure 1: Location of Glasgow and Stoke-on-Trent

Meanwhile over one third of the 15% most deprived zones in Scotland are in Glasgow despite a significant improvement in the figures for the city since 2004 (Scottish Executive, 2006b). Employment figures in Glasgow are well below the Scottish and UK average with just 68% of people of working age in employment (Scottish Government, 2008). Male life expectancy in Glasgow is just 70.8 years, the lowest in Scotland (General Register Office for Scotland, 2008), and in some areas of Glasgow's East End male life expectancy can be 15 years less than the city average. This alarming male life expectancy is consistent with an environment where alcohol abuse, drugs and a poor diet are major problems. This trend inevitably leads to serious physical and mental health problems in the area with high levels of cancer, heart-attacks, diabetes, drug overdoses and suicides (Gillan, 2006).

This statistical information on Glasgow and Stoke-On-Trent shows similarities between the two. However the experiences of regeneration in both cities have been different in the years following the National Garden Festivals (1984-1992) where along with Liverpool, Gateshead and Ebbw Vale, they were chosen to host botanical events on derelict land which intended to show the potential of Brownfield sites and kick start regeneration.

In the years since Glasgow's Garden festival in 1988 the city has moved forward on a culture and events led strategy with a positive trajectory. Two years after the Garden Festival Glasgow became European City of Culture, was the UK City of

Architecture and Design in 1999, European Capital of Sport in 2003 and now looks forward to hosting The Commonwealth Games in 2014. All of these events have been punctuated with other landmarks such as the opening of the Gallery of Modern Art (1996), the Clyde Auditorium, designed by Sir Norman Foster (1997) and the Glasgow Science Centre shown in Figure 3 (2001).

Figure 3: Glasgow Science Centre

With regard to useful vehicles for regeneration, events such as those pursued by Glasgow are seen as particularly effective catalysts for city regeneration. It has been said that cultural venues should act as a catalyst for both activity and investment and restore previously derelict areas through the conversion of properties for cultural uses (Montgomery, 1990). The Work Foundation (2006) maintains in the Knowledge City Regions publication that major events can be utilised effectively as catalysts of economic growth and to raise the profile of a city. This is, to some extent, the approach used by Glasgow, in relation to its market size.

Yet, despite the perceived success of Glasgow's forward steps, the social problems within the city are still evident as illustrated by the statistics referenced previously. This perhaps explains the relatively average response from citizens when asked about the effectiveness of major events in regeneration. Research carried out by the authors suggests that 55% of those asked thought major events were effective catalysts and drivers of regeneration.

The experience in Stoke-On-Trent has not had similar momentum to that of Glasgow. Following an interview with John Gething, Regional and European Strategy Manager at Stoke-On-Trent City Council, certain factors were put forward as explanations for the perceived lack of activity. Mr Gething (2008) pointed out that Stoke-On-Trent doesn't have a traditional and concentrated city centre and that can lead the city as a whole to have a physically disjointed feel as a result of its composition of five towns. In light of this, Mr Gething asserted that it was a matter of priority for Stoke-On-Trent to create a true sense of a town centre and improve both the physical and social connectivity of the five towns, particularly between Stoke and Hanley.

Another obstacle noted by Mr Gething was that people from Stoke-On-Trent tend to identify with their own local areas (i.e. whichever of the traditional five towns they are from) and so have a propensity to be narrow-minded about the city area as a whole. With this in mind, it seems convincing the communities in these areas that this kind of development will be beneficial could pose difficulties.

This leads to the report Transforming North Staffordshire by the influential think tank, The Work Foundation (2008). The report warned that the region was at a pivotal point in its bid to make a difference through regeneration and would have to act fast in this make or break situation. The result of the Work Foundation's hard hitting report was the launch of a draft plan detailing blueprints for securing investment and improving quality of housing, education, transport and employment.

Both Glasgow and Stoke-On-Trent stress a commitment to communities in their local authority documents namely the Glasgow City Plan (Glasgow City Council, 2003) and the Stoke-On-Trent Regeneration strategy (City of Stoke-On-Trent Council, 2003). Yet despite the regeneration which has occurred social problems within both cities persist and although some improvements have been made crime, unemployment, ill health and other social issues continue to affect communities.

These cities are indicative of the situation elsewhere in the UK where in cities like Liverpool, Manchester and Newcastle there has also been a considerable regeneration effort yet similar social issues affect many communities. If regeneration is to be successful and address the problems exacerbated by industrial decline it cannot solely rely on the physical improvement of the urban fabric and economic progression as outcomes. Zizek (2002) alludes to the fact that the developed First World enjoys such a status as direct result of the imbalance between itself and the developing Third World. This analogy can be compared with the situation in many cities where the attractive areas of towns and cities are invested in to the detriment of disadvantaged communities in other areas. It is imperative to address the social issues which affect communities in such areas in order to compliment and facilitate the veritable regeneration of cities and towns. The application of design thinking to issues such as these, which affect communities in Glasgow, Stoke-On-Trent and elsewhere in the UK, can be viewed as a progression from using problem solving skills in more traditional elements of design, such as with products, and utilizing that expertise in the context of the regeneration of communities through the attentive design of urban environments.

4 Design Thinking

A design-led approach to regeneration can deliver significant benefit to the community and make a difference physically, economically and, importantly, socially. It has been suggested that poorly designed urban environments contribute to and can be directly related to a poor quality of life. In addition, the negative effects of urban environments which are badly designed (Figure 4) are more likely to impact on the lives of those who already experience hardship such as poverty and ill health in disadvantaged areas (CABE, 2008).

Figure 4: Barlanark, Glasgow

Elkin, McLaren and Hillman (1991) declare that cities require a built environment which promotes social interaction while simultaneously deterring vandalism and other petty crime.

In an interview with the authors, Rob Hay (2007), Regeneration Liaison Officer at Strathclyde Police, agreed wholeheartedly with this sentiment and confirmed the assertion that poor urban design contributes to an adverse social life. Mr Hay states unequivocally that bad design facilitates crime and affirms that there is without doubt a direct correlation between the types of urban design implemented in a place and the amount of crime that occurs. Good implementation of urban design can reduce instances of opportunist crime, such as vandalism, by refusing to provide an environment for it, in most cases areas which have a lack of natural surveillance and are of poor design quality (Figure 5).

Figure 5: Vandalism in the urban environment

Furthermore, Mr Hay believes without doubt that crime is a way for certain members of the community to manifest their discontent with their environment. He states that CCTV, although excellent as an investigative tool, is not effective as a preventative measure. It is true to say that if CCTV is introduced solely to a notorious high-crime environment the culture facing that environment will not be changed. However, if it is delivered as a package of measures, particularly one which includes lighting in the public realm, then transformations in the social and cultural problems in an area stand a better chance of achievement. The restoration of Civic Pride is a factor in this theory as the urban environment can be designed to contribute to crime prevention, promote community interaction, increase sociability in terms of public space and improve public transport. Creative thinking and a design-led approach in urban regeneration can have a positive economic effect by addressing the problems of crime, social exclusion, safety and wellbeing through attentive design of the urban environment.

Creativity and creative thinking is an aspect which has been underutilized in many cities, particularly in the UK, when approaching urban regeneration. In an interview with the authors, architect David Mackay (2008) advocated the thoughtful design of places and avowed that individual buildings did not make a city and more thought had to be put into the overall creation. Mr Mackay reference the Distrito Forum building in Barcelona (Figure 6) as an example. Good architecture is just that and simply selecting well designed buildings will not create a sense of place.

Figure 6: Distrito Forum, Barcelona

Architect David Chipperfield (2006) laments the insensitive architecture we see nowadays and asserts that many buildings regretfully have no dialogue with their surroundings and neglect the history of the environment which they inhabit. He continues to state that what we call regeneration has simply become an exercise in building for maximum profit and attempting to attract the attention of the media.

Although it has been said that unique and distinctive projects can help raise the profile of a city, this point addresses the need for thought and considerations of application in such flagship ventures. There is a tendency for cities to “follow suit” and this breeds a “tick the boxes” mentality in the approach to urban regeneration (Hassan, Mean & Tims, 2007). This kind of lack of initiative and inventiveness in urban regeneration projects impacts on the sense of uniqueness and “belonging” which the end products have within the established urban fabric of an area and how they are received by the citizens.

This also inevitably leads cities, from far and wide, to attain a similar urban aesthetic and thus lose their identity and distinctiveness. Heritage is important in cities and even although regeneration aims to resolve physical, economic and social issues it is important that a sense of heritage is not completely replaced with shimmering buildings, flagship bridges and inauthentic cultural quarters. The solutions to the problems which regeneration sets out to address must be more creative and original than simply following the herd in terms of architecture and culture. Each city has a uniqueness which gives it character and vitality and it is imperative to keep these qualities.

Creativity is a key aspect to the development and regeneration of post-industrial cities. Richard Florida (2004) asserts that a great driving force of economic growth in the 21st century is the ability to be innovative with existing knowledge. The “creative class” have the ability to provide this in the urban environment and the lives of those who inhabit these areas by delivering innovation and driving economic growth.

Lord Rogers (2005) states that many of the recommendations from the Urban Task Force have been adopted by the Government but indicates that there are still issues which require attention. Interestingly, some of the most significant issues raised by the report are design-related, for example, the limited design advice given to Ministers and City Councils; the lack of exemplary urban projects produced in the UK; and the lack of design input at cabinet level and therefore paucity of design quality in outcomes of the built environment.

Guy Julier (2005) argues that with the ubiquity of global cities and their aims in urban regeneration it is up to the influential leaders in the creative industries to help forge an identity for a place within their broad categorisation as a “cosmopolitan hub”. The influence of the creative industries within regeneration can be of great significance if the potential is allowed to be reached. This potential is that design-led regeneration can advance culture and economic development by relating to the creative industries.

Design-orientated economic development initiatives promoting the local creative industries and linking their work with local manufacturing can assist cultural and economic progression. Bell and Jayne (2003) assert that when local production is linked to local manufacture and is locally consumed, a significant benefit to the local economy can be seen, even when such products are internationally marketed and sold.

This aim of utilizing the creative industries in regeneration certainly seems to be an achievable goal, particularly in the UK. The document Staying Ahead, a collaboration between The Work Foundation and the Department for Culture, Media and Sport (2007) asserts that the UK has the biggest creative sector of all the EU nations and possibly the largest globally relative to GDP when compared to other countries.

5 Design Guidelines

In light of what has been said thus far, it is possible to formulate guidelines for design and design thinking in urban regeneration. The importance of engagement with the client cannot be disregarded. In dealing with the urban environment, designers should view the communities within the environment as the clients and consultation as part of initial research should be conducted with those who live, work and use those places and spaces. However, it is important to find more creative and imaginative ways of engaging with these communities. Old fashioned consultation is neither creative nor engaging and the Author's research indicates that it is viewed with some scepticism and perceived a token gesture in many cases.

Furthermore, it is not enough to concentrate solely on the economic and physical aspects of urban regeneration. Social issues are intensified in areas which have experienced the effects of industrial decline and so must be tackled as part of regeneration. There is little evidence to suggest any trickle-down impact in disadvantaged communities of a purely economic focus on regeneration, especially when areas become gentrified in the process. In such situations those most likely to benefit from improvements in the public realm are unable to take advantage due to the exclusive nature of gentrification towards the less affluent members of society.

However, creative solutions in these communities to problems which the urban environment intensifies can potentially have an economic impact. For example, restoring a sense of civic pride within certain communities by adding value (Figure 6) to their environment through design and design thinking in the urban realm has the potential to reduce instances of vandalism which, as aforementioned, can often be viewed as a manifestation of discontent. Reducing instances of vandalism therefore eases the need for spending on resources and maintenance to combat such petty crimes.

Figure 7: Hope Street, Liverpool

It is also important to recognize that the implementation of good architecture alone does not necessarily make for a quality environment. In addition, the consideration of symbolic value and significance of meaning regarding architecture and products and furnishings, such as lighting and benches, within the public realm should be carefully considered in order to maximize their contribution to the quality of life of the community.

The uniqueness, heritage and identity of a place are important and should not be ignored. Progress and change is possible economically, socially and physically without a regeneration-by-numbers approach and indeed stands more chance of success if the solutions are case specific and not borrowed from and influenced by other examples.

6 Concluding Remarks

In conclusion, it can be understood that design can play a significant part in the physical transformation of an area by improving it in terms of appearance and its ability to sustain the local economy and business as well as having an impact in social transformation. However, it is important to remember that many of the social issues affecting communities will not be tackled if the area is gentrified. If the communities and businesses that regeneration would benefit most can no longer afford to live and work in that environment the social problem is not solved, it is merely moved on elsewhere. These are issues which if ignored can have a negative impact on the regeneration efforts in Glasgow and Stoke-On-Trent as well as other cities.

Through the attentive design of the urban environment it is possible to reduce instances of crime and anti-social behaviour by restoring a sense of civic pride in communities and providing a quality environment. If an environment is designed well it can provide fewer opportunities for anti-social behaviour and if the products within the environment are designed and implemented well the quality of life for the community can be improved. The application of design thinking in regeneration can allow communities to benefit from regeneration in terms of the attractiveness of the urban environment and a bolstered local economy as well as the significant social benefits which a well designed and implemented urban environment can achieve. Design thinking employed in holistic approach to the issues which negatively affect communities can be a valuable asset in creating lasting and sustainable solutions within the urban environment.

7 References

CABE (2008) Inclusion by Design: Equality, Diversity and the Built Environment. Commission for Architecture and the Built Environment; London, UK

Couch, C; Fraser, C; Percy, S (2003) Urban Regeneration in Europe. Blackwell Publishing; Oxford, UK; ISBN 0-632-05841-2

Chipperfield, D (2006) Chipperfield on Building for Regeneration in City of Sound see www.cityofsound.com/blog/2006/2007/chipperfield_on.html (accessed February 19th 2007)

City of Stoke-On-Trent Council (2003) Regeneration Strategy. Regeneration & Community Department; Stoke-on-Trent, UK

City of Stoke-On-Trent Council (2006) City of Stoke-On-Trent Health Profile 2006 see http://www.stoke.gov.uk/ccm/cms-service/stream/asset/?asset_id=1595355 (Accessed 17th January 2008)

City of Stoke-On-Trent Council (2007) English Indices of Deprivation 2007: Stoke-On-Trent see http://www.stoke.gov.uk/ccm/cms-service/stream/asset/?asset_id=1619784 (Accessed 17th January 2008)

Department for Culture, Media and Sport / The Work Foundation (2007) Staying Ahead: The Economic Performance of the UK's Creative Industries. Department for Culture, Media and Sport; Crown Copyright 2007; London, UK.

Elkin, Dr. T; McLaren, D; Hillman, Dr. M (1991) Reviving The City: Towards Sustainable Urban Development. Friends of the Earth; London, UK; ISBN 0-905966-83-X

Evans, M (2008) Promises Kept, Problems Remain After 30 Years of Atlantic City Casinos in USA Today 5th October 2008 see http://www.usatoday.com/news/nation/2008-05-10-atlantic-city-casinos_N.htm#uslPageReturn (Accessed 8th October 2008)

Florida, R (2004) Cities and the Creative Class. Routledge; New York, USA; ISBN 978-0-415-94886-9

General Register Office for Scotland (2008) Life Expectancy for Administrative Areas within Scotland, 2005-2007. National Statistics; Edinburgh, UK; Crown Copyright, published 25th September 2008.

Gething, J (2008) Interview with the Author. February 26th 2008. Stoke-On-Trent City Council, Civic Centre, Stoke-On-Trent, UK.

Gillan, A (2006) In Iraq, life expectancy is 67. Minutes from Glasgow city centre, it's 54 in The Guardian. January 21st 2006.

Glasgow City Council (2003) City Plan: Parts 1-3. Development & Regeneration Services; Glasgow, UK

Hackworth, J (2002) Postrecession Gentrification in New York City in Urban Affairs Review, Vol. 37, No. 6. Sage; London, UK see http://uar.sagepub.com/cgi/content/abstract/37/6/815 (accessed May 6th 2008)

Hassan, G; Mean, M; Tims, C (2007) The Dreaming City: Glasgow 2020 and the Power of Mass Imagination. Demos; London, UK; ISBN 978-1-84180-186-5

Hay, R (2007) Interview with the Author. March 29th 2007. Strathclyde Police Headquarters, 173 Pitt Street, Glasgow, UK.

Jacobs, J (1961) The Death and Life of Great American Cities: The Failure of Town Planning. Penguin Books Ltd; Harmondsworth, UK; ISBN 0-14-02-0681-7

Julier, G (2005) Urban Designscapes and the Production of Aesthetic Consent in Urban Studies, Vol. 42, No.5. Routledge; London, UK; ISSN 0042-0980

Lozano, E (1990) Community Design and the Culture of Cities. Cambridge University Press; Cambridge, UK; ISBN 0-521-38979-8

Mackay, D (2008) Interview with the Author. September 4th 2008. MBM Arquitectes, Placa Reial 18, Barcelona 08002, Spain.

Montgomery, J (1990) Cities and the Art of Cultural Planning in Planning Practice and Research, Vol. 5 No. 2. Routledge; London, UK; ISSN 1360-0583

Roberts, P; Sykes, H (2000) Urban Regeneration: A Handbook. Sage; London, UK; ISBN 0-7619-6717-6

Rogers, Lord R (2005) Towards a Strong Urban Renaissance: An Independent Report by Members of the Urban Task Force Chaired by Lord Rogers of Riverside. Urban Task Force, UK; November 2005

The Scottish Executive (2006a) A Literature Review of the Social, Economic & Environmental Impact of Architecture and Design. Government Social Research; Web Only Publication; ISSN 0950-2254; ISBN 0-7559-6151-X

The Scottish Executive (2006b) Scottish Index of Multiple Deprivation: General Report. Scottish National Statistics; ISBN 0-7559-5209-X

The Scottish Government (2008) Economic Briefing for Glasgow. Analytical Services Division update 15th October 2008 see http://www.scotland.gov.uk/Resource/Doc/933/0023454.doc

West Midlands Regional Observatory (2008) West Midlands Regional Economic Assessment: Stoke-On-Trent (version 3.0, October 2008); WMRO Research Team; Birmingham, UK see http://www.wmro.org/resources/res.aspx?p=/CmsResource/resourceFilename/2248/RIEA-Stoke_v3.0_Report_SH.pdf

The Work Foundation (2006) Ideopolis: Knowledge City-Regions (City Case Studies Executive Summaries) The Work Foundation; London, UK

The Work Foundation (2008) Transforming North Staffordshire. London, UK March 2008 see http://www.theworkfoundation.com/assets/docs/publications/35_Transforming_North_Staffs_overview.pdf

Zizek, S (2001) The Desert of the Real: Is this the end of fantasy? In These Times, vol. 25, iss.24; October 29th 2001

Action for sustainability: challenges facing Syrian plan for sustainable urban development

Dr Husam al Waer[1], Dr Mohamed El-Haram[1], Dr Zakaria Al-Cheikh Mahmoud[2]

1 – University of Dundee, UK

2 – Al-Baath University, Syria

Sustainable development and by extension sustainable urban development, are evolving concepts that depend upon the development of regional and local approaches and solutions. There is a differentiation between the definitions, approaches and priorities in developed and developing countries. Most definitions of sustainability are unhelpful because of their wordiness, lack of detail or ambiguity. Also, in Syria, a chaotic urban context has existed over the past 50 years; the urban government handles urban as piecemeal solutions. The lack of a long term solution for urban growth and urban policies integration has always been the case in the Syrian urban planning process. Subsequently, creating a national agenda for sustainable urban development in country like Syria is required to bridge the gab between developed and developing countries.

This paper focuses on providing the critical requirements for achieving sustainable urban development, by analysing the opportunities and constraints in the case of Syria. The key requirement is the establishment of a solid knowledge foundation for Syria that will equip the public, urban development stakeholders, architects and planners with accurate and relevant knowledge generated within the framework of the social and economic needs, its cultures and its biophysical environment to guide their decisions and actions towards establishing a sustainable urban environment. Finally, the paper raises questions for future research into the need for new national framework and legislation considering sustainability dissensions, and highlights clearly the practical benefits of treating the urban environment and its components as a whole.

Keywords: Syria, challenges, sustainable urban development, urban growth, sustainable development

1 Introduction

Syria lies on the eastern costal of Mediterranean Sea. It has a total area of 185,180 kilometres of which 14 per cent is occupied by urban areas. Each region is called a Mohafaza (Governorate) (Al-Cheikh Mahmoud, 1993, p. 287). Syria is divided into four regions: Southern, North-Eastern, Middle and Coastal regions; and further into urban and rural areas. Each Governorate (Mohafaza) encompasses many zones, each of which is called Mantique (zone). Since the middle of the last century, Syria has experienced rapid population growth, average increase of 3% per annum, the population which in 1971 was 6.3 million has greately increased to an estimated18 million in 2002 (Central Bureau of Statistics, 1995; Al-Cheikh Mahmoud, 1993, p. 287). The percent of the population between 0 –14 was calculated at 40.5%. The annual population growth rate was estimated at 2.7%. Total Life expectancy for men and women was 69.6 years and 71.6 years, respectively (Johannesburg Summit, 2002, p. 7).

The distribution of population growth appears to be largely due to regional preferences, the relative shortages of housing in all major urban centres and the development of employment opportunities. It is essential to state that, while the proportion of the total population in the major cities has continued to rise, yet their relative share of the total urban population of the country as a whole has slowly fallen. This is explained by the relatively faster development of smaller urban centres (Mohmoud, 1993). The significant socio-economic changes that took place in Syria society accelerated population migration from rural to urban areas, of which major cities like Damascus, Aleppo and Homs always received the largest portion. With the fast growth of the city population, land and housing in major cities Damascus, Aleppo and Homs came under increasing pressure. In addition, industrial development that generated economic growth and provided much needed employment, but also contributed to air, land and water pollution with resulting ill health. The result of industrial expansion in Syria is not only waste gases from factories and industrial activities but also emissions whose impacts are little understood (Clarley and Christie, 2000, p. 15).

This paper focuses on providing a critical analysis of the potential for achieving sustainable urban development in the case of Syria which is experiencing rapid urban growth, by analysing the challenges and constraints facing social and economic needs, its cultures and its biophysical environment. The categorisation and analysis of the selected issues is based on written materials evaluated by the authors. This paper argues that urban government planners in Syria have ignored sustainable urban development opportunities for improving the quality of both nature and built environments, instead the implementation of sustainability has been regarded from a very acute perspective focused on mainly economic considerations. It is concluded that, radical changes must be initiated to address a rapid urban growth situation in Syria, and that new strategies and comprehensive frameworks are required to address these problems holistically.

2 Sustainable Urban Development

More than seventy definitions of sustainable development have been identified and interpreted by different organizations, groups and stakeholders to suit their own goals (Macklely, 2001). Such definitions however, have in common the same concerns of:

- Living within the limits of earth resources.
- Understanding the inter-relationship between economy, society and environment
- Equitable distribution of resources and opportunity.

These propositions demonstrate that there is growing concern about the long term future, taking into account the exploitation of the resources of the planet, the impact on the environment and the continuing high levels of poverty, to which are linked social unrest, population growth and environmental degradation.

The most popular definition of sustainability is the one presented in the Brundtland Commission on Environment and Development “Sustainable Development is development that meets the needs of present generations without compromising the ability of the future generation to meet their needs and aspirations” (Bentivegna, et al, 2002, p. 85). The key features of the concept are (Meadowcraft, 2000):

- It focuses on promotion of development, or progress;
- It places a priority on the ‘needs’ of the poor and those of future generations;
- It refers to environmental limits to human activity;
- It defines sustainable development as a process of improvement rather than any particular activity.

Sustainable development is classically portrayed as the interface between environmental, economic and social sustainability” (Bell and Morse, 2003, p. 3). It cannot achieve a sustainable system by providing answers for each system independently. However, achieving a balanced design in terms of sustainability is not always easy because there are numerous interactions and many of them may be in conflict with needs which have to be satisfied simultaneously (Clements-Croome, 2004, p. 373). Consequently, the attempt to separate the ecological application from the economic dimensions results in the wrong conclusion.

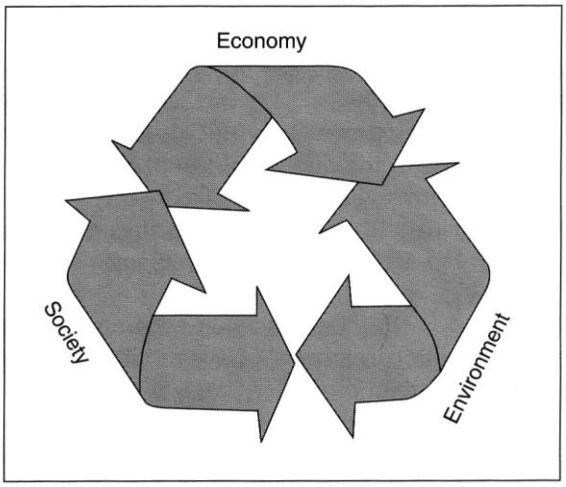


Figure 1. The decision making cycle for sustainable development. Source: Du Plessis, 2004, p. 381.

The concept of sustainability at global scale contains some common consensus on the following issues (Ibrahim, 2007, p. 43):

- Sustainable Development does not only refer to environmental protection but also embraces the economic and social aspects (WCED, 1987, p. 46). SD must encompasses the three inter related aspects of the environmental, social and economic aspects.
- Sustainability related to a dynamic, balanced, and adoptive evolutionary process, i.e. a process in which a balanced use and management of the natural environmental basis of economic development is ensured (Camagni et. al, 1998, p104).

The idea of sustainable urban development has been seminal and highly significant among intellectuals and policy makers in the 1990s (Pugh, 2000, p.1). While there has been no consensus in what constitutes comprehensive framework about sustainable urban development, the fundamental ideas around which sustainable urban development can be formulated in the years to come are (Du Plessis, 2005, p. 406):

- Meeting basic human needs within environmental limits;
- Through limiting impact and consumption;
- In a cooperative world of networked settlement;
- In partnership with nature;
- In solidarity with future generations.

While there are certain universals in the five outlined aspects of sustainable urban development, there is considerable divergence in opinion regarding which approaches, priorities and drivers should take precedence (Du Plessis, 2005, p. 406). The application of the five outlined principles of sustainable urban development is determined by local conditions, including local cultural constructs, community behaviour and preferences, especially value systems.

3 Challenges facing urbanisation in Syria

The distribution and morphology of cities, the dynamics of urban growth, the linkages between urban and rural areas and the living conditions of the rural and urban population also vary quite substantially over time (United Nations, 2008, p. 364). In general, urbanization represents a positive development, but it also poses challenges and limitations. The scale of such challenges is particularly significant in less developed regions, where most of the urban growth takes place in the main cities. Urbanization has significant social, environmental, and economic implications: Many important economic, social and demographic transformations have taken place in Syrian cities. The urban expansion, due in part to migration from rural to urban areas, varies significantly across regions and cities. Figure 2 shows major socio- economic trends and their consequences in Syrian urban growth. The following section describes the key challenges facing the urbanisation in Syria.

Major Socio-economic trends And pressures	**Major consequences**
Population growth	Poverty
Urbanisation and Industrialisation	Resource depletion
Urban – Rural comparisons	Loss of rural land
Job opportunities	
Housing affordability	A decline in natural vegetation
	High Unemployment rates
	Shortage in housing affordability
Changes in land use	Pollution
and land- cover	Air
	Fresh Water
Global access	Global climate change

Figure 2. Major socio- economic trends in Syrian urban growth

4 Urban- rural comparisons

Significant socio- economic changes, which took place in Syria society after independence in 1946, accelerated population from rural to urban areas, of which Damascus, Aleppo and Homs always received the largest portion. The factors promoting rural- urban migration consisted of planned growth of industries, mechanisation of agriculture and a limited success of agrarian reform in the rural areas. There are essentially two ways in which a country becomes urbanized. The first way is through the natural growth of the urban population. The second way is by rural-urban migration.

In Syria, rural poverty and caste are forcing many people, especially the unskilled and the land less to seek employment in the large cities. Rural poverty, the hope and often the reality of better chances for work and income in the city and improved transport encourage this movement (Clarley and Christie, 2000, p. 15). In the rural to urban population shifts over the past century, cities have provided a large proportion of the population, with social services and shelter. The importance of urban-urban migration should not be under- estimated. Between 1995 and 2000, 295000 people representing 2.1% from the whole Syrian population migrated as follows (Alsalomee, 2003):

- from rural to urban 44%;
- from urban to rural 27%;
- from rural to rural 6%;
- from urban to urban 23%.

Although Syria is still dominated by rural- urban immigrations, a new trend has emerged demonstrated by urban- rural migrations from 1995. The level of migration varies between cities due to different reasons, such as job opportunities, house prices and security. The largest cities in Syria have accounted for around 42% of the country population since 1960, and more than 44% by 1970 (Alsalomee, 2003). According to UNCHS (Habitat 2001, p. 13) in Syria "urban growth rates will remain higher than total population growth rates in the foreseeable future. … Urban growth has been the result of rural-to-urban migration as well as high fertility and declining rates of mortality."

5 Planning and Administrative

Increased industrialisation and urban growth, in the absence of comprehensive planning and regulation to tackle the pressure on the local environment, have caused adverse impacts during over the last two decades. The energy sector is the major polluter in the country, because of the increased burning of fossil fuels in the form of petroleum products in all the economic sectors, i.e. transportation, industry and power generation as well as domestic applications (Jaber and Probert, 2001, p.126).

Also, severe inequalities of opportunity continue in Syria. This is identified in access to land, clean residential environments, nature reserves, as well as basic services: the poorest have least access to these amenities. One of the most important urban issues due to the rapid increase of population and rural-urban migrant is the lack of use of the existing planning policy and regulations which were implemented decades ago. These regulations do not meet the current scenario demand and aspirations. Urban governments handle urban growth piecemeal. The absence of long- term vision for urban growth and poor integration urban policies has always been the case in Syria in urban planning. The chaotic situation has generated complex urban problems, manifested in the form of vast urban growth on agricultural land, daily commuting to the inner city, increased rate of private automobile dependency, and increased rates of air and water pollution.

Syria has been through a series of urban planning strategies since 1970 – which had a main objective of developing the agro-industrial economy and called for reaching a "balanced population distribution". However, some of the early applied plans between (1970-1976) have not been further updated and therefore the strategies have not met the demand of the increased of the population (Al-Cheikh Mahmoud, 1998, p. 288). The Syrian urban planning policies responded to urban issues without fully taking into consideration the consequences of current decisions on present and future generations. Additionally, the Syria urban government envisions sustainable urban development from a very acute perspective, taking account mainly of economic considerations, without fully understanding the strong interdependence of the social, environment and the political aspects embodied within the sustainable urban development framework (Ibrahim, 2007; Alsalomee, 2003) .

6 Economic Issues

The growth of cities in Syria and the concentration of human population in large metropolitan areas present huge challenges for modern urban societies. The form of construction of businesses, housing, roads, leisure centres, and the metropolitan regions face the growing problems of urban sprawl, including a decline in natural vegetation, wildlife habitats and agricultural land due to the increased number of migrations from rural to urban areas. Economic growth drives urban expansion to require more land for various urban needs. This expansion takes the form of (Ibrahim, 2007, p. 39):

- Housing needs to fulfil the needs of the growing number of families.

- Transportation needs in the form of creating an accessible road network for travel-to- work and commercial needs.
- Social and commercial activities required to fulfil the needs of the urban population.
- Degradation of natural and built environment because of the increase of economic activities and urban sprawl.
- Urban and economic are sources of employment. This has resulted in a redistribution of work from rural to urban activities (labour force who works on natural vegetation has been declined from 21.1% to 13.6% (Alsalomee, 2003). The differences between the two have been seen in other activities focused in cities such as (trade activities, industry…). The continuous reduction in labour force in rural areas has dramatic consequences on rural development.

According to El Laithy and Abu- Ismail 2005, during the period from 1996-1997 to 2003-2004, all regions witnessed a slight increase in their GDP (Gross Domestic Product) per capita and the average per capita expenditure grew from 3,085 Syrian Pound (SP) (around $ 62) to 3,541 SP ($71) per month, representing an annual growth rate of 1.9%. There are, however, major differences in expenditure per capita at the sub-national level – with GDP per capita expenditure being higher in the Southern part of Syria, totaling 4,110 SP ($83) per month (with an annual growth rate of 2.1%). Per capita expenditure for the North-Eastern region on the other hand has remained at 3,487 SP ($70) per month in 2003-2004.

The Middle region recorded the highest rate of growth of all four regions (3.9% annually), while the Coastal region recorded the second highest per capita GDP in Syria at 4,023 SP ($81) per month. Its annual growth rate however was the lowest, 0.56%, per year (El Laithy and Abu- Ismail, 2005, p. 3). A research carried out by Government of Syria, UNDP found that the incidence of poverty in Syria has decreased from 14.3% in 1996-97, to 11.3 per cent in 2003-2004. On the whole, the poverty rate in Syria appears to be in line with more affluent countries such as Lebanon, Jordan and Tunisia. However, the study revealed, in 2003-2004, almost 2 million individuals in Syria (11.4% of the population) could not obtain their basic food and non-food needs (El Laithy and Abu- Ismail, 2005, p. 1).

GDP growth indicated Syria has an issue of a declining contribution of investment to growth and a significant reliance on oil exports. On the supply side, growth in agriculture and mining sectors was the driving force behind the episode of high growth (1996-1998). Subsequently, both sectors were hit hard by unfavorable external factors (oil prices and rainfall), which caused the overall rate of growth to decline despite a noticeable rise in the contribution of services in the later period.

Thus, there are three main challenges facing the Syrian economy over the coming decade, which directly and indirectly influence the prospects for poverty reduction (El Laithy and Abu- Ismail, 2005, p. 21):

1. *there is the challenge of accelerating and establishing a sustainable foundation for economic growth:* economic growth in Syria faces a sustainability problem. Firstly, the Syrian economy is typically characterised as highly centralised and under full public sector control. Foreign trade was exclusive to public sector enterprises, foreign investments were restricted and, with the exception of a small number of public enterprises, most of the production was geared towards satisfying local demand. Secondly, the growth of the Syrian economy has been held back by oil revenues and the change in oil prices. This implies non-oil exports should increase dramatically to offset the expected loss of foreign exchange resources.
2. *there is the problem of growing unemployment.* In this respect, Syria faces a serious challenge. Unemployment has been steadily increasing in Syria (from 5 % in 1981 to between 11.6-16.2 % in 2002). Each year over 380,000 people, with varying degrees of education and skills, enter the labor market, which does not offer sufficient job opportunities. This is associated with a substantial increase in the size of the labor force particularly of the younger age groups who also constitute a bulk of the new job seekers in the labour market. Considerable investments will be required in order to accommodate the growing demand for jobs and to improve the quality and skills of the labour force to meet the challenges of globalization.
3. *the Syrian public sector requires major financial and operational restructuring.* The government's main challenge is to find viable and cost-effective measures to tackle the fundamental problems of technology, labour and debt in the public sector companies so as to increase their productivity and reduce their fiscal burden. This will significantly improve the public sector's contribution to growth. Judging from other country experiences, the rehabilitation of public sector enterprises can be a very costly process since a large proportion of firms may need both financial and operational restructuring, i.e. those with large debts, poor market prospects, technological weaknesses, and excess labour. One of the greatest challenges to the economic reform program in the future will be to re-vitalise the more troubled segments of its public sector portfolio, without incurring excessive costs in the process.

Unemployment rates increased from 5% in 1981 to 11.6 per cent in 2002 and the percentage of people working less than two days per week reached approximately 812,000 in April 2003 – 16.2% of the labour force (El Laithy and Abu- Ismail, 2005, p. 18). According to the 2003 unemployment survey, unemployment is concentrated mainly among the youth, mainly in the 20-24 year age group, which represents 24 per cent of the unemployed. In addition, 57% of the unemployed belonged to the lower educational categories. Middle educational categories (mainly vocational and technical) represented 40 per cent of the unemployed. The remaining 3.2% belonged to higher educational categories, (university degree holders) (El Laithy and Abu- Ismail, 2005, p. 18). The recent research study shows that the labour force demand in Syria will be based on the following (Alsalomee, 2003):

- Continue increase of females entering the labour market.
- Reduction in the agriculture labour market.
- The majority of the companies and organisations run by one or two employees- preponderance of micro- enterprises and self- employed.
- A rapid increase in the labour force.

7 Social and Cultural issues

These aspects present challenges for planners especially in relation to policies and actions because they require integrated policies to impact sustainability. In developing world cities low per capita income and high social- class disparities determine a disadvantaged life style that is oriented towards daily survival and by less access to basic social services such as education, health and sanitary infrastructures. All these services allow people to change their habits, to raise their standard of living and avoid environmentally damaging social behaviour (Button, 1992). Many researchers have pointed out to issues related to social- cultural aspects of sustainability due to rapid urban growth in Syria, such as, unemployment rate, crime, poverty, lack of social and community integration. This is coupled with the dramatic consequence of rapid urban growth in housing supply and demand. Housing supply has focused on satisfying the demand from medium and high income households. This issue has obliged families with very low household income to live in one or two rooms. This is contradictory to basic human rights, relating to health, social and moral aspects. In addition, this coupled with the fact low household income coerced to work in low income jobs which does not meet their minimum needs (education, health, security…). In short, the urbanisation is one of serious social and economic inequity between economic groups.

8 Environmental issues

Urban growth and regional environmental problems have originated in cities because of the high concentration of people and the resulting human activities. The process of urbanisation increases the land use and the use of energy with consequent deleterious effects on natural environment. In general, the level of urbanisation influences both levels of energy use and green house gas emissions (see Jones, 1991 and Parikh and Shukla, 1995). The rapid urban growth in Syria highlights the specificity of city problems, in particular the case with growing income inequity and urban segregation, the concentration in Syrian large cities, as well as high levels of pollution and the development of informal, unregulated settlements that often constitute the largest areas of urban residential spaces (Porter and Sheppared, 1998, and Bonine, 1997). Industrial activities operated by both private and public sectors in major conurbations (such as Damascus, Aleppo, Homs, Tartous, and Banias) are responsible to some extent for the degradation of the quality of watercourses, ground water, and the surrounding environment. This is mainly due to the lack of sufficient funding to install treatment technologies before discharging polluted effluents to the environment (Johannesburg Summit, 2002, p. 37). Also, the city engendered problems such as traffic congestion air pollution due to daily car usage, daily commuting generations of noise pollution, public safety...etc. as a result, fossil fuel consumption has dramatically increased during the last two decades, so increasing the emissions of air pollutants in the main cities and in the neighbourhoods of new industrial cities.

The main reasons for local air pollution problems are (Jaber and Probert, 2001, p.127):

- Excessive rate of energy consumption and the inefficient use of the limited local resources.
- High sulphur-content in the fuel combusted.
- Use of leaded gasoline.
- Old ``vehicle fleet'' and the motor vehicles' relatively low (<20%) efficiencies.
- Uncontrolled waste-treatment plants.
- Unpaved roads.
- Burning solid-wastes, including scrap tyres (especially without heat-recovery).

Industrial pollution and vehicle emissions in the more intensively developed regions in Syria were found to be dangerous to human health in the last decades, based on various studies conducted by the national health services. There is a lack of systematic national air pollutants emission inventories, national ambient air quality monitoring network and industrial emission measurements. The national meteorological monitoring network is old and insufficient (Johannesburg Summit, 2002, p. 11). In addition, Syria is suffering from an accumulating quantity (230 tonnes) of expired pesticides that need to be handled as hazardous wastes (Johannesburg Summit, 2002, p. 26).

Figure 3: Industrial pollution has dramatically increased during the last two decades. Source: Al-Cheikh Mahmoud, 2009.

In Syrian cities, urban growth has a further impact on the basic urban environmental services, such as clear drinking water, sanitary facilities and solid waste collection. In addition, rivers and lakes in major cities are now receiving untreated industrial and domestic effluent and are dangerously polluted. For instance, Barada river in Damascus, with the fast growth of the city population, land and housing developed has increased pressure on water resources, including Barda river which as result has a level of dissolved oxygen of almost zero where waste water are released into water ways daily. In addition, agriculture is the largest water-consuming sector in Syria accounting for about 87% of water use. The domestic and industrial water use stand at about 9% and 4% respectively. While the urban water demands is rapidly increasing due to strong population growth rate (about 3% per annum) and industrial growth, new water sources are becoming scarce and extremely expensive to develop. Water deficits are expected to worsen placing additional stress on all uses. Since drinking water needs are given top priority in the government's policy, water availability for agricultural use could face severe constraints (Salman and Mualla, 2002, p.1).

Pressure on water resources of the country comes from all sectors of the economy with highest demand from agricultural sector. In 2000, the cultivated land area in Syria was estimated at 5.5 million hectares, which accounted about 30% of the total country area. Twenty per cent of the cultivated land area (1.2 million hectares) was irrigated. The Euphrates and the Orontes basins account for the major share. The total irrigated area increased from 650 000 hectares in 1985 to 1.3 million ha in 2002 (Somi et al, 2001 and 2002). This rapid expansion of irrigated agriculture is mainly attributed to the government policy objective of achieving food self-sufficiency and a remarkable increase in groundwater irrigation. Unfortunately, if water demand at current prices continues to increase in the same way, Syria will experience an alarming deficit between the mobilisable resources and the potential needs in the near future (Salman and Mualla, 2002, p.1).

In a recent research carried out by the National Technical Committee for Sustainable Development in Syria and based on consultations with stakeholder groups from industry, universities, central and local government, environmental issues were ranked in order of priority. National development objectives and economic costs were considered in parallel with the degree of public concern. The NTCSD project unit and consultants used the information gained in making a final determination of priorities. The outcome was a list of the priority problems in Syria, in order of importance as follows (the National Technical Committee for Sustainable Development, 2001, p. 12):

- Contamination and depletion of water resources.
- Land degradation and desertification.
- Poor air quality.
- Inappropriate solid waste disposal.
- The growth of illegal unregulated settlements.

In addition, a number of secondary issues were identified which, although limited in extent, are either responsible for acute localized effects or frustrate redemption efforts. These comprised the following (in no particular order):

- Lack of public awareness of environmental issues and sustainable development.
- Inadequate industrial site management and safety;
- Coastal degradation.

Each of those problems has a range of causes cutting across several sectors. To indicate where actions should be focused, the information is briefly summarised in Table 1, which links the priority environmental problems with their effects and causes (the National Technical Committee for Sustainable Development, 2001, p. 13).

Table 1: illustrates a brief summary of each of those problems, Priority problems, effects and causes. Source: the National Technical Committee for Sustainable Development, 2001, p. 13.

Problem	Main Effects	Proximate Causes
Poor quality and depletion of water resources	• Eventual loss of agricultural production. • Difficulty in meeting the increased demand of potable water. • Risk of drought. • Increased illness and premature death from waterborne diseases. • Risk of epidemics. • Increased cost of wastewater treatment • Risk of non-communicable diseases (i.e., poisoning and cancer)	• Over abstraction of groundwater. • Increased irrigated crops. • Use of inapproprtiate irrigation methods. • Lack of sufficient sewerage network, treatment plants, and safe disposal methods of sewage solid waste. • Unregualted industrial discharges. • Leachate from uncontrolled solid waste disposal sites. • Lack of National Water Strategy.
Poor air quality	• Increased illness and premature death from various diseases. • Reduced visibility. • Degradation of public buildings, monuments, historical sites, rubber and plastic materials due to acid droplets and corrosion process.	• High traffic congestion. • Old and poorly maintained vehicles fleet. • Poor quality of vehicle fuels. • Unregulated industrial emissions and absence of EIA. • Inefficient burning of indoor heaters.
Inappropriate solid waste disposal	• Public nuisances (odor, vermin, smoke, litter) • Risks to public health • Groundwater pollution	• Inefficient indoor heaters • Lack of sanitary landfills • Lack of hazardous waste repositories • Poor location and inadequate management of disposal sites
Illegal settlements and unregulated town planning	• Poor living conditions in unregulated developments • Loss of heritage • Noise, fumes and time loss due to traffic	• Inadequate town planning • Over-crowding • Unclear land tenure system • Rural-Urban Immigration.

9 Urban planning and Housing

The pressures on urban growth has led to a remarkable challenge at national level as a whole, resulting in massive development and expansion to cities and in particular horizontal development in order to accommodate extra residential housing. This situation or phenomena if it continues to develop (the recent trend shows this as a continuous process) this will lead to the situation of Damascus becoming a Mega-city such as Mexico city or Cairo.

Housing is considered as an important need of the community; hence the policies of housing distribution in the community include demand, size, quality and location. Housing has been a major issue in urban policy due to a constant shortage of affordable housing for low-income sectors, which form a large portion in any country. The rapid population growth in cities like Damascus, which has quadreafed in size since 1950 has made the actual demand for land and housing much more than what the plan projected by the government. Furthermore, the consecutive modifications of the plan constituted a significant hindrance to land development (Amer, 1992 in Al-Cheikh Mahmoud, 1998). This resulted in a widening of the gap between demand and supply of land for housing and other requirements of urban development. Consequently, land prices started moving up excluding an increasing number of people who could not compete with higher income categories in land auction, the only land supply channel existed at that time. Houses the only supplier of which was the private sector, were increasingly going beyond the reach of a large number of people as their prices increased sharply with the shortage of land supply and the increase of its prices (Al-Cheikh Mahmoud, 1998, p. 297-298).

The rapid urban growth in Syria has resulted in the absence of affordable housing, the lack of green and open spaces and severs employment and transportation problems. In Syria the population in large cities has increased up to 8.7 million inhabitants in 2002, this is three times what was the number in 1970. This means either expand the existing dwelling units in 1970 in order to accommodate growing families number in 2002 by about three times, or expand cities three times what was in 1970. The recent studies show that the new required dwelling units is estimated from 15000-20000, whereas the dwelling units being constructed are less than this figure.

New housing is too expensive for lower and middle class workers and has attracted speculators rather than residents. As it discussed earlier, the actual population growth rate is significantly higher than that which projected in the proposed Government plan. This made the housing programme inadequate to the actual needs of the city population. The increasing pressure on land and housing price increased not only their prices but also housing rent in the city. This situation forced many of the new comers to the city, who were not able to have an access to a shelter in Damascus, to seek cheap agricultural land in the periphery, and to illegally construct unauthorised settlements. These areas became a part of the city when it is boundaries were extended (Al-Cheikh Mahmoud, 1998, p.298). Despite the huge efforts made by the government to organize and administer the situation in major urban and suburban areas (such as Damascus and Aleppo), irregular human settlements pose a real threat to the surrounding environment and place an immense pressure on limited number of available resources. For example, supply of drinking water for major conurbation is a real problem as well as the management of resulting solid wastes (Johannesburg Summit, 2002, p. 9). The noticeable differences between the actual course of population growth and that one envisaged to support the opinion of authors such as (Mc Auslan, 1985; Doeble, 1986; Payne, 1989; Devas and Rakod, 1993 in Al-Cheikh Mahmoud, 1998) who put a question mark on the appropriateness of the concept of master plan to guide the city development in developing countries (Al-Cheikh Mahmoud, 1993, p. 305).

10 Priorities and the way forward

The challenges identified in this paper are a results of environmental, social, and economic not having been taken adequately into account in preparing previous plans. The absence of any long-term vision for urban development growth and lack of urban policies integration has lead to a chaotic situation which generate various urban problems, manifested in the form of vast urban growth on agriculture land, unavailability and poor quality of housing and infrastructure, socio-economic issues, increase rate of pollution to air, water and land. However, the Syrian government has responded to the urban problems without fully integrating the environmental and socio-economic issues and without taking into account the consequences of current decisions on present and future generation.

The National Strategy for Sustainable Development in Syria introduced the Syrian National Environmental Action Plan which is very major step to: a) integrate the national development plans and environmental management; b) to contribute to the protection of the health Syrian population; c) manage scarce materials and cultural resources and d) to allow economic growth to continue unimpeded by environmental degradation (NTCSD, 2002).

Recently the Syrian Government has ratified a number of international conventions (e.g. Montreal protocol, Climate change, World heritage convention for culture and natural sites, convention on Biodiversity and others). At the national level, the Syrian government has taken major steps such as establishment of Ministry of Environment, the Higher Council for Environmental Safety and General Commission for Environmental Affairs. The Syrian established General Environmental Directorates which will require to be followed at local levels.

The way forward is to research and introduce various approaches to tackle the major challenges related to sustainable urban development:

- Move from the extreme centralisation to the greater, but proportionate empowerment of the local government and participation of private sector and other non-governmental organisations and societies in decision-making
- Make critical changes to the urban planning bodies at the state and local government levels to empower public agencies to plan and implementation more effectively.
- Provide a long-term strategy with targets and a time-frame to meet the state objectives of sustainable urban development agenda and increase the coordination at state and local levels.
- Increase transparency and accountability at state and local governmental level
- Provide training for public and private agency staff which is needed to deliver best practices solutions to urban problems.
- Better mobilise state and private investment to deliver best practise solutions to urban problems.

11 Conclusion

The Syrian government envisions sustainable urban development from a very acute perspective which has not fully considering social, economic and built environment and political aspects embedded with the sustainable urban development framework. The paper argues that in order for the Syrian government to achieve sustainable urban development agenda, it requires to increase the awareness of sustainability at all levels of urban stakeholders (national, local and project). It is also need to encourage them to adopt the principles of urban sustainable development and the use of sustainability assessment tools and techniques where appropriate. The paper also highlighted the need to introduce new polices at all levels to address the problems and challenges facing the sustainable urban development agenda to improve the quality of both human lives and the nature.

References

Al-Cheikh Mahmoud, Z. (1998). Cross-National Comparison of Strategies to Deal with Unauthorised Colonies in Selected Asian Cities. Unpublished PhD thesis, The University of New Delhi, School of Planning and Architecture. New Delhi.

Alsalomee, S. (2003). Urban Growth in Syria. Unpublished Post-Graduate Diploma thesis. The University of Al-Baath, College of Architecture, Department of planning and Environment. Homs: Syria.

Bell, S., and Morse, S. (2003). Measuring Sustainability: Learning by Doing. London: Earthscan.

Bentivegna, V., Curwell, S., Deakin, M., Lombardi, P.,Mitchell, G., Nijkamp, P.(2002). A vision and methodology for integrated sustainable urban development: BEQUEST. Building Research & Information 30 (2), 83 – 94.

Bonine, M. (1997). Population, Poverty, and Politics in Middle East Cities. Gainesville: University of Florida Press.

Button, K. J. (1992). Transport Regulations and the Environment in Low Income Countries, Utility Policy 25 (4), 248-257.

Camagni, R., Capello, R., and Nijkamp, N. (1998). Towards Sustainable City Policy: an Economy-Environment Technology Nexus, Ecological Economics 24 (1), 103-118.

Clarley, M., and Christie, I. (2000). Managing sustainable development, edition 2. Earthscan: London

Clements-Croome, D.J. (2004) Intelligent Buildings: Design, Management and Operation. London: Thomas Telford.

Du Plessis, C. (2005). Action for sustainability: preparing an African plan for sustainable building and construction. Building Research and Information 33(5), 405-415.

Du Plessis, C. (1999). Sustainable Development Demands Dialogue Between Developed and Developing Worlds. Building Research & Information 27 (4/5), 379-390.

El Laithy, H. and Abu-Ismail, K (UNDP). (2005). Poverty in Syria: 1996-2004 Diagnosis and Pro- Poor Policy Considerations. United Nations Development Programme (UNDP).

Fuller, R., Jong, U. D., and Mellersh-Lucas, S. (2008). The Ethics of Sustainable Housing Design: The Dilemma for Practicing Architect. Architectural Science Review 51(3), 231-238.

Ibrahim, M. Y. (2007). Promoting Sustainable Urban Development under Conditions of Rapid Metropolitan Growth: The Case of Greater Cairo. Unpublished PhD thesis, The University of Liverpool, Department of Civil Design. Liverpool.

Jaber, J.O., and Probert, S.D. (2001). Energy demand, poverty and urban environment in Jordan. Applied Energy (68), 119-134.

Johannesburg Summit. (2002). Syrian Arab Republic- Country Profile. UN: United Nation; Johannesburg: South Africa

Jones, D. W. (1991). How Urbanisation Affects Energy- use in Developing Countries. Energy Policy 19 (7), 621-630.

Mackley, C. (2001). 'Sustainable Development' in Langston, C.A., and Ding, G.K.C. (Eds), Sustainable Practices In The Built Environment. Oxford, Butterworth-Heinemann, pp. 15- 24.

Meadowcraft, J. (2000). Sustainable development: a new(ish) idea for a new century? Political Studies (48), 370–87.

Mohamoud, Z. (1993). Urban Dynamics and Development Process- Homs Syria. Unpublished Thesis Report, School of Planning and Architecture, New Delhi: India.

NTCSD (The National Technical Committee for Sustainable Development). (2002). The Syrian National Strategy Report for Sustainable Development. World Summit on Sustainable Development. Johannesburg: South Africa.

Parikh, J., and Shukla, V. (1995). Urbanisation, energy and greenhouse effects in economic development. Global Environmental Change 5 (2), 87-103.

Porter, P., and Sheppard, E. (1998). A World of Difference, New York: The Guilford Press.

Salman, M., and Mualla, W. (2002). Water Demand Management in Syria: Centralized and Decentralized Views. Available at : ftp://ftp.fao.org/agl/iptrid/conf_egypt_03.pdf.

Somi, G., Zein, A., Dawood, M., and Sayyed-Hassan, A. (2002). Progress Report on the Transformation to Modern Irrigation Methods until the end of 2001. Internal Report, Ministry of Agriculture and Agrarian Reforms, Syria (in Arabic).

Somi, G., Zein, A., Shayeb, R., and Dawood, M. (2001). Participatory Management of Water

Resources for Agricultural Purposes in the Syrian Arab Republic. Internal Paper, Ministry of Agriculture and Agrarian Reforms, Syria (in Arabic).

UNCHS, Habitat. (2001). Cities in a Globalising World. Global Report on Human Settlements. Nairobi: UNCHS.

United Nations (Department of Economic and Social Affairs). (2008). Population Division United Nations Expert Group Meeting on Population Distribution, Urbanization, Internal Migration and Development, New York.

World Commission on Environment and Development (WCED). (1987). Our Common Future, London: Oxford University Press.

Upgrading informal settlements in Egypt towards a sustainable urban development

Prof. Khaled Dewidar, Dr Ayman Hassan, Inji Kenawy, Nourhan Magdy
The British University in Egypt, Egypt

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It is about ensuring a better quality of life for everyone, now and for generations to come. This requires meeting four key objectives that are the social progress which recognize the need of everyone; the effective protection of the environment; the prudent use of the natural resources and the maintenance of high and stable levels of economic growth and employments. Informal settlements are areas where groups of housing units have been constructed on land that the occupants have no legal claim to, or occupy illegally; an unplanned settlements and areas where housing is not in compliance with current planning and building regulations (unauthorized housing). In developing countries, cities are experiencing a real demographic explosion. This paper will deal with the problem of the informal settlement phenomenon in Egypt and the means of its upgrading by adopting the concept of sustainable urban development. It applies SWOT-AHP method to analyze stakeholders' perception of quality of life and their relationship to sustainable development. Results revealed significant agreement between stakeholers' groups of perception of strengths, threats and opportunities.

Keywords: community sustainability, environmental sustainability, stakeholder participation, sustainable development, urban development, urban sustainability

1. Introduction:

The urban environmental crisis will continue to be one of the most pressing problems facing humanity in the twenty-first century. Most of the world's gravest environmental threats to air quality, water quality and availability, waste disposal, and energy consumption are exacerbated by the high density and activity of urban life. Governments acting alone cannot successfully address these challenges. What is needed are partnerships between development stakeholders: local governments, the private sector, non-governmental organizations (NGO's) and citizens' groups working together to find solutions. In urban centers, two of the most pressing problems facing the world today come together: poverty and environmental degradation. To improve the quality of life in urban areas, efforts must be made to reduce poverty and environmental threats to the most vulnerable sectors of society. To address the challenges of the urban environment, it will promote an inclusive approach to problem-solving, building on partnerships between all stakeholders to address complicated human settlements questions.

2. Sustainable Development:

Human beings are at the centre of concerns for sustainable development, since people are the most important and valuable resource of any nation. The right of development must be fulfilled so as to meet equitably the population, development and environment needs of present and future generations and a higher quality of life for all people. Sustainable development is a dynamic process whose goal is to ensure indefinitely the real welfare of society through the co-optimization of economic development, state of the environment, quality and level of employment. The concept of sustainable development is based on the principles of inter-generational and intra-generational equity. Going towards sustainable development aims at the benefit for the entire human race of the present and of the future. It also requires fundamental disruptive innovations at every level of the society, on local and global scale. Sustainable Development is depending on Integrating population and development strategies.

3. Quality Of Life (QoL):

Quality of life is the degree of well-being felt by an individual or group of people. Szalai (1980) defined Quality of Life (QoL) as the degree of excellence or satisfactory character of life. A person's existential state, well-being, satisfaction with life is determined on the one hand by objective facts and features of his life and on the other hand by the subjective perception and assessment he has of these facts and factors, of life and of himself. QoL consists of two components: physical and psychological. The physical component includes factors such as health, and protection against pain and disease. The psychological component includes stress, worry, pleasure and other positive or negative emotional states. Measuring differences in quality of life is as a difference in the *"standard of living"*. Achieving Quality Of Life (QoL) has been the implicit goal of public policy in nearly all societies for many centuries.

The quality of life (QoL) index is a social indicator proposed by Nathwani et al.(1997) to reflect the expected length of "good" life, in particular the enhancement of the quality of life by good health and wealth. The distinction between quality of life indicators and sustainability indicators is that the former measure what is happening today and the latter measure the capacity for what will happen tomorrow.

This paper investigates stakeholders' perception of quality of life indicators. Incorporating perceptions of stakeholder groups is essential for ensuring successful formulation and implementation of any policy that leads to sustainable urban development. The research is based on the case of "Cairo", Egypt. Understanding perceptions of such stakeholders will help in identifying the priorities of QoL indicators which should be addressed in future urban development strategies. Addressing such issue will help in reducing conflicts and improving cooperation among the different stakeholder groups.

4. Case Study: Cairo Slum Areas

Cairo is the largest city in both Africa and the Middle East, capital of Egypt for over a thousand years, and an important political and cultural focal point in the region. The population of Greater Cairo is currently around 14-15 million inhabitants, which represents almost a quarter of Egypt's population of 67 million inhabitants and almost half of the country's urban population. (Table 1).

Table (1) Growth of the population of the Greater Cairo Region (GCR)

Census Years	Cairo Gov.	Giza Gov.	Qaliubila Gov.	Region	Rate (%)	Population
1947	2.062	0.668	0.281	3.013	n/a	12.5
1960	3.356	1.118	0.434	4.910	1.82	15.7
1966	4.232	1.420	0.560	6.211	4.50	17.4
1976	5.74	2.137	0.879	8.090	2.68	18.5
1986	6.069	3.332	1.460	10.860	2.99	18.2
1996	6.789	4.273	2.081	13.144	1.93	17.3

Currently the population of Greater Cairo is estimated to be growing at roughly 2.0 per cent annually. However, the labor force is probably growing at over 3.0 per cent per annum, due to the large youth bulge in the population pyramid now reaching working age.

The problem of transformation of urban patterns in Cairo stems from different reasons. These reasons were: a rapid increase in population not matched by additional new housing units, internal migration from rural to urban centres, deterioration of old parts of the cities without up-grading or equivalent replacement, accumulation of housing shortage over the years, and finally, the increasing gap between the cost of housing and income levels.

The transformations of the urban patterns can be summarized as follows:

1- Decline of traditional districts.
2- Deterioration and vertical expansion of colonial districts.
3- The absence of coherence in modern districts.
4- Transformation in public housing estates.
5- Growth of informal settlements.

Informal sector housing has become widespread, accounting for an estimated 70% of all new construction in Cairo due to the absence of an effectively implemented master plan and of adequate support of low-income housing, and with the increase of immigration from rural areas to the city.

5.1. Urban Slums:

The term slum "*aashwa'i*" is the only one used officially to indicate deteriorated or under-served urban areas, implying that these areas are unplanned and illegally constructed. Thus they are not necessarily slums, although being informal/ illegal, they tend to be the least well served in terms of infrastructure and public services, and they suffer from poor accessibility and high levels of overcrowding. Government officials and the national press frequently see these areas as "black stains" and ascribe to them a whole set of social ills – crime, drugs, and 'backwards' behaviour. In Greater Cairo a total of 81 *aashwa'i* areas were identified, of which 63 were deemed upgradable and 18 smaller pockets were slated for demolition and the resettlement of the inhabitants. Informal settlements have both positive as well as negative aspects. (Table 2).

5.2 Classification of Slums in Cairo:

The following are descriptions of the main types of slums found in Greater Cairo. Salient features and relative sizes are presented (Table 3). The location and geographical extent of these types are also presented (Figure 1).

Table 2: Positive and negative aspects of slums

Positive Aspects	**Negative Aspects**
A. Components of unauthorized development represent a true manifestation of the inhabitants' real needs and requirements but in an unorganized and unplanned fashion. These real needs and requirements may be difficult to arrive at through conventional means of survey and questionnaires. B. Literature on the matter indicates in numerous examples that squatter settlements are more eventful, lively and full of activities if compared with other pre-planned public housing districts. C. Current literature calls for a change of Perception of unauthorized development from a criminal act that deserves punishment and eradication to study it and deeply analyze its components in order to arrive at a useful conclusion in upgrading and re-planning this development.	A. Unauthorized development represents a great shame to the modern city and an eyesore to governments as a constant reminder of their weakness and inefficiency. B. The wide spread of disease and infection in squatter settlements is imminent due to lack of infrastructure such as drinking water and sanitation coupled with severe shortage of health and medical services. C. Squatter settlements present a host environment for criminals and outlaws since they provide them with a safe haven from police forces due to the difficulties of controlling these areas and knowing their roots in advance. D. The negative effect of unauthorized development is not only limited to its boundaries but it extends this to the surrounding areas.

Table 3-Greater Cairo Slum Types and Estimates of Prevalence 1996

Typology	Population	%of total GC population	%of total GC residential area
Type A Informal Settlements on Former Agriculture Land	6,434,000	56.4%	46.1%
Type B Informal Settlements on Former Desert State Land	6,434,000	56.4%	46.1%
Type C Deteriorated Historical Core	n.a.	> 4%	n.a.

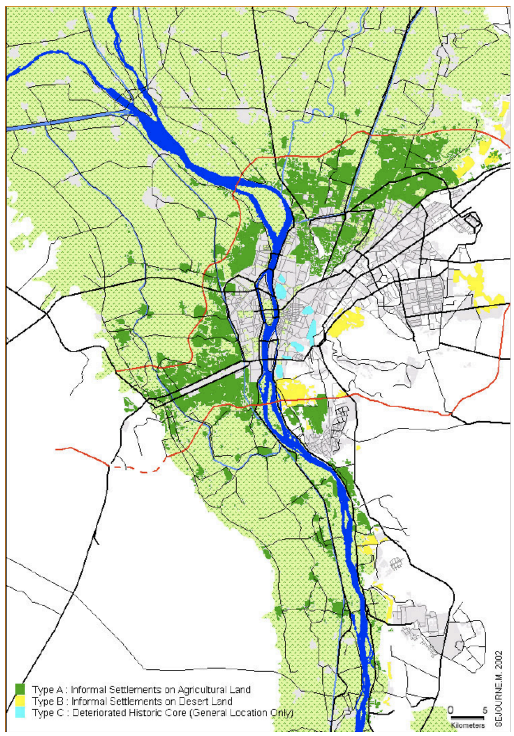


Figure 1- locations of informal settlements in Greater Cairo

5.2.1. Type A: Informal Settlements on Former Agricultural Land

This typology is defined as private residential buildings constructed on agricultural land purchased from farmers in areas where there were no subdivision plans and where building permits were not given. The typology contains over half the population of Greater Cairo and almost half the total residential area. The phenomenon has its roots in the 1960s, when small agricultural areas began to be subdivided by farmers and sold to individual owner-builders. The process was completely informal in the sense that land was bought and transferred and buildings were erected with no legal paper work and a total reliance on personal trust, mediated when necessary by the existing community. The annual loss of 600 hectares of valuable farmland to the growth of Cairo is one of the most serious problems confronting the planning authorities.

In physical terms, the layouts of these informal areas are always determined by the prior agricultural field and irrigation patterns, with canals becoming the only main thoroughfares. Local streets are straight and very narrow (usually 2-4 metres), the minimum required to allow access. Plots tend to be small, ranging from 60 to 140 m2 with 80 m2 being average. Frontages are usually 7 to 10.5 metres. There is 100 per cent plot coverage except for small air shafts or light wells. Buildings are mainly of reinforced concrete frame and floor slab construction with red brick infill walls and are designed for at least five floors.

5.2.2. Type B: Informal Areas on Former Desert State Land

This typology is defined as private residential buildings constructed on vacant state land by citizens under the process of "hand claim". The history of the phenomenon is particular to each location. In every event a core settlement was allowed to take hold, slowly expanding as the usual neglect of the government towards its own property became apparent. Usually quite large plots on the fringes of the established core were walled, and then sub-parcels would be sold by these pioneers to other settlers. The development process was also completely informal, with no legal paper work and a total reliance on personal trust, mediated when necessary by the existing community.

These areas are illegal, but settlers have certain customary rights derived from interpretations of those portions of the civil code pertaining to hand claims on desert land. In any event, settlers amass either the receipts from paying a nominal rent imposed by a Governorate's properties Department or property tax, from electrical connections, and other items to gain as much paper legitimacy as possible. Although it is difficult to generalize, housing conditions are in general worse than those found in Type A. There are higher incidences of dilapidated structures and of whole families living on one room.

5.2.3. Type C: Deteriorated Historic Core

In the historic city, that is Cairo before the expansions which began after 1860, are found neighbourhoods with a high percentage of old, crowded, and deteriorated structures within the medieval urban fabric. Examples include Darb el Ahmar and El Gamalia (especially the eastern sections along the Fatamid walls). The deteriorated buildings found in these areas are the result of confused ownership (mostly inheritance quarrels) and/or owner neglect due to controlled rents.

5.3 Policies and actions taken to improve slums and alleviate poverty:

5.3.1. Geographical Targeting and the Government's National Fund for Urban Upgrading

In 1992, after the problems of informal urban areas were highlighted by a serious earthquake and also due to security problems in some of these areas, the government launched a national Fund for Urban Upgrading. A survey of informal urban settlements was carried out nationally, and areas were classified as either in need of upgrading or removal and replacement. The main problems in these areas were identified and upgrading focused on 909 areas in six investment sectors: electricity, planning and organization, municipal cleanliness, water, sanitary drainage, and road paving.

In 2000 a review of this national program was carried out by the Institute of National Planning. It pointed up a number of problems and deficiencies, the most important of which were as follows:

A. accurate and systematic information on informal areas and their needs were lacking frequently funds were allocated for large infrastructure projects that only partly served needy informal areas, going instead to prestige roads, bridges, etc. in nearby formal urban areas.
B. It was often impossible to track what funds were actually spent on informal areas due to rigid accounting procedures.
C. There was a marked difference between projects planned, those approved, and actual executed investments.

5.3.2. Socio-Economic Targeting and the Rural Bias in Poverty Alleviation

Overall, the Egyptian Government's attempts to alleviate poverty have never been particularly well targeted. The formal social safety net includes a number of compensatory measures run by the Ministry of Insurance and Social Affairs and its affiliates which are aimed at the poor and vulnerable groups. There are two main types, social assistance programmes which provide cash transfers and subsidized credit to qualifying poor households, and social insurance programmes which provide payments to former workers and also some non-contributory schemes.

5.3.3. NGO Activities

Over the last 15 years Egypt has witnessed a rapid increase in the number and scope of NGOs aimed at social development and fighting poverty which specifically aims at the problems of urban slums and poverty.

They are supporting an Urban Upgrading Unit in each governorate with the following objectives:

A. Defining the framework for improving living conditions in informal settlements.
B. Preparing a participatory strategic plan for each area and setting priority interventions in coordination with other agencies.
C. Disseminating participatory development mechanisms for identifying problems, priorities, and upgrading interventions by local stakeholders (government, NGOs, and private sectors).
D. Coordinating the strategy and efforts of upgrading informal areas with other development issues.

This study uses SWOT-AHP (Strength, Weaknesses, Opportunities, and Threats Analytical Hierarchical Process) framework to identify differences among perceptions of four different urban development stakeholder groups (non-governmental organizations [NGOs], government, industry, and academia) regarding urban development in the in slum districts of Cairo. The scope of this study is on small district level, but the findings of the study may be applicable for other districts facing similar situations. Moreover, if required, the same methodology can be replicated in each district to assess perceptions of local stakeholder groups.

5.4 Study Area: Garbage City (Zabaleen):

In Cairo, an informal-sector group of garbage collectors, known as zabbaleen, and local contractors, known as wahis, The zabbaleen, many of whom might otherwise be homeless and without employment, collect and transport the waste. They live in an area known locally as Garbage City who are mostly descendants of poor farmers from Upper Egypt who settled in the city in the 1950s with an estimation of (60,000 - 70,000 in number). Many of them suffer from health problems such as hepatitis, due to the low-tech sorting methods used and general poverty. They have two major problems, among others: The health and sanitation issues associated with living off trash, and the prospect of losing income as the positions of competitors strengthen.

5.4.1. The Problem:

Living Conditions:

The settlement has no water supply, and very few of the homes are supplied with electricity (main lines have been strung in only a few streets). The sorting of the refuse inside the houses leaves them cluttered and often filthy. This situation is mirrored by the condition of the roads, which are heaped high with waste paper, piles of animal manure mixed with organic residues, tin cans, and often animal carcasses. Some streets cannot be seen at all due to layers of wastepaper or tin cans strewn, often a foot or more deep, across large areas. Others are divided down the middle by piles of organic residues up to 6 feet high. Millions of flies swarm about, and the air is usually filled with the smoke of fires which have either been set deliberately to dispose of unwanted paper or result from spontaneous combustion of organic residues.

Insecurity:

In the absence of any water supply on site, fires frequently get out of hand, and large sections of the community have been entirely destroyed on several occasions. Fortunately, loss of life has been limited, but many families have lost all of their material possessions several times in the past 10 years. Despite the installation of fire extinguishers at strategic locations in the community in 1980, the fear of fire never leaves the people of The Gabbal. This fear combines with the uncertain land tenure to create an atmosphere of general insecurity, and must surely do a great deal to dampen the interest of the Zabbaleen in cleaning up their settlement and improving their homes.

Population:

Zabaleen also suffered from increased overcrowding, in part because of the new trend of two story brick and stone dwellings. Families who used to live in one story houses now built two-story houses on half their land and sold the other half, raising the population of Moqattam and putting an even greater strain on the environment and the almost non-existent services.

Services:

The amenities of urban life in zabaleen are almost wholly lacking at The Gabbal. There is no government school, no consumers' cooperative, no health clinic or pharmacy. Four private doctors hold regular clinic hours at Zabaleen, but cannot begin to meet the health needs of a population of this size. While there is an abundance of grocery shops, greengrocers and butchers, prices are quite high for some essential goods such as meat and sugar, at least partly because of the absence of competition from a cooperative. There is no sewerage system, not a single telephone, and no means of transporting emergency patients to the hospital.

5.4.2. The Zabbaleen Environmental and Development Project

Despite the general view of the Zabbaleen as an unproductive, backward community, a small minority of Egyptian and international environmentalists began to take a serious interest in their life and work. They were impressed by the industriousness of the Zabbaleen in rendering waste collection and disposal services to a city as large as Cairo and were particularly intrigued by their ingenuity in creating work from waste for tens of thousands of low-income residents. Environmental Quality International (EQI) received a grant from the Ford Foundation to assist in upgrading the living conditions of the Zabbaleen.

Another major participant in the Zabbaleen Environmental and Development program was the Zabbaleen Gameya. Members of the Gameya were the heads of the most prominent families in garbage collection and acted as its leaders. The Gameya was concerned with the interests of the garbage collectors, especially the very poor. The program consisted of a number of projects initiated over a span of five years and was based on an exploratory, experimental approach whereby project ideas and designs emanated from the learning experience acquired by EQI's team in the field and from their interaction with the environment and the community participation who was considered as the project greatest resources. Program was directed at both Zabaleen life and their work. More specifically, intervention activities were targeted at improving environmental and living conditions, promoting enterprise among community residents, increasing the service capacity of the Zabbaleen, and instituting low-cost technological innovations.

Program Components:

A. Area Upgrading and Infrastructure Extension Project:

The project was aimed for the construction of basic infrastructure and facilities to upgrade settlement. It provided basic infrastructure services and addressed the settlement's need for educational and health services. Piped water, electricity, and sewerage networks were installed. The streets were leveled and paved. A map of the settlement was drawn and names were given to the streets and numbers to the buildings. A primary school and a health center were established. This led to a dramatic rise in the value of land, and gave the residents a feeling of security. Thus, many of the Zabbaleen sold parts of the land they occupied at prices that were very profitable considering that the land theoretically belonged to the State. In addition to land tenure problems, the infrastructure project had other unforeseen consequences. The infrastructure which was appropriate at the beginning of the project is no longer able to withstand the increased demand placed on it, and breakdowns of the system abound.

B. The Internal Clean-up Project:

This project received funding from the ford foundation, oxam, and the soeur Emmanuelle fund. The aim of the project was to improve the level of cleanliness and sanitation in the settlement. Zabbaleen residents, under the direction of the Gameya, removed tons of accumulated waste and manure from their settlement. However, the project has faltered, and the settlement is once more home to piles of refuse. The main reason is that the project ceased to be economically viable. Once the installments on the trucks were paid, the owners had no incentive and were no longer as committed as before to collecting the settlement's household waste. The project's problems were further compounded when the nearby municipal dump was closed, with the service becoming erratic; people started throwing their waste in the local dumping grounds established higher in the settlement or anywhere else in the streets.

C. The Small Industries Project:
This project was funded by Oxfam, and was designed to provide the Zabbaleen with new business opportunities related to their trade. The project concentrated on establishing small community-based recycling industries designed to maximize the resource value of waste, the Small Industries project enabled Zabbaleen families to buy plastic granulating machines to recycle plastic and rag pulling machines to recycle rags.

D. The Women-Headed Households Project:
This project was funded by the Ford Foundation, and was designed to provide income generating opportunities by extending credit to widows, divorcees, and women with unemployed or disabled husbands, who represent the poorest and most vulnerable group in the settlement. The key to the success of the project has been the role played by the extension workers, described as the lifeline of the Women Headed Household Project, and follow-up have made the project, which is still in operation, one of the most successful components of the Zabbaleen Environmental and Development Program.

E. Healthcare Projects:
There are a variety of healthcare projects serving the Zabbaleen in Moqattam and raising awareness of health issues, especially among women. The Maternal Health Care Program trains girls from the community as health visitors to promote general health awareness for pregnant mothers. The health visitors of the Health and Immunization Program, a project run by the Association for the Care of Garbage Collectors, also carry out similar services. Being chosen from the community, the health visitors have easier access into the homes of the community members than complete strangers.

5. SWOT-AHP framework

SWOT analysis is a strategic management tool that helps to identify internal strengths and weaknesses and external opportunities and threats for any organization, project, or individual (Houben et al., 1999; Dyson, 2004). Many applications of SWOT analysis exist in strategic management (Nair and Prasad, 2004). The combination of a brainstorming session and SWOT analysis with a heterogeneous group of stakeholders constitutes a useful strategy to rank different factors and identify relevant issues (Mollenhorst and de Boer, 2004). One of the main restrictions of SWOT analysis is that the significance of each factor in decision making cannot be measured quantitatively and therefore, it becomes complicated to judge the potential of a factor to influence strategic decisions. When SWOT analysis is combined with AHP (Analytical Hierarchical Process), importance of each factor present in the SWOT categories can be measured, and the effect of a single factor on the overall decision can be assessed (Saaty and Vargas, 2001). AHP enables the stakeholders to assign a relative priority to each factor through pairwise comparison. From these pairwise comparisons, the relative priority value of each factor within each SWOT group is computed using the eigen value method. The SWOT-AHP analysis used in this paper is adapted from Dwivedi & Alavalapati (2009).

6. Method:

A contact list of professionals working on different aspects of urban development in the Zabbaleen District, Cairo was prepared. This list was based on personal contacts, publications, projects awarded by different government and private agencies, state government agencies with a focus on slum area urban development, feedback from previously identified stakeholders, and comprehensive internet search. To identify the factors in each SWOT category, an open- ended questionnaire was administered to all the identified stakeholders. Questionnaire was electronically sent, and responses from 37 experts were obtained. Responses were analyzed and suitable factors under each SWOT category were extracted (Table 3).

Table (3) Relevant factors identified in each SWOT category.

Strength	Weakness
S1: Using the industriousness of the Zabbaleen in rendering waste collection and disposal services to a city as large as Cairo to set a base for recycling and solid waste project creating job opportunities. **S2**: The Integration between the NGOS and the local community. **S3**: Taking the local community as one of the main stakeholder in decision making. **S4**: Directing the upgrading project mainly to the community life and work. **S5**: Increasing the service capacity of the garbage city. **S6**: Area upgrading and project infrastructure project. **S7**: improving the sanitation in the garbage city. **S8**: Participation between NGOS and the local community to promote general health awareness for pregnant mothers. **S9**: considering the women-headed household project as a base for the success of the project. **S10:** Creating job opportunities for the unemployment problem through the small industries project. **S11**: the equity in decision making between the local society and NGOS.	**W1:** Lacking for water supplies in zabbaleen and the total ignorance from the government. **W2:** The lost of trust between the local community, NGOS and the government. **W3:** the lack of the effective participation from the government with the local community and NGOS. **W4:** The absence of the government participation in solving the problem and considering it as a hopeless case. **W4:** The local community is lacking for awareness of the importance to participate in decision making with NGOS. **W5:** The government doesn't take any responsibility towards any upgrading actions in zabbaleen. **W6**: Lack of Coordination betwee n different Organizations in the community and their policies and managements which led to lack of awareness. **W7:** Uneven Distribution of benefit. **W8**: Poor Management and Leadership Skills, Lack of Human Resource Development.

Opportunities	Threats
O1: Community Participation. **O2**: The Ability to Coordinated and cooperative partnerships between funding, development, government, and community agencies. **O3**: Connecting Environmental Improvement to Enterprise Development. **O4**: Recognizing Alternatives to New, High-Tech, Externally Imposed Solutions. **O5:** Partnership involving Funding Organization to fund the projects.	**T1:** Poor Management and Leadership Skills **T2**: the unacceptable living conditions. **T3**: the lack of insecurity. **T4**: the overcrowded population with the bad living conditions. **T5**: the lack of services either educational, health, or commercial.

Based on the factors identified in each SWOT category, a second questionnaire was prepared. A brief explanation of each factor was included in the questionnaire to ensure a common understanding among the respondents. This questionnaire contained pairwise comparisons of each factor in a particular SWOT category against all other factors in the same category. Respondents were classified into five stakeholder groups namely population, NGOs, government, industry, and academia. Seven respondents representing each of the five stakeholders groups conducted this questionnaire. The respondents were asked to evaluate both the factors present in a pairwise comparison and then to mark order of importance of one factor over another based on their own understanding. While administrating the questionnaire, the numbers were replaced by more familiar scale of comparison (1 "Equal", 3 "Moderate", 5 "Strong", and 7 "Very Strong") to facilitate respondents. The questionnaire was administered on February 5, 2009 at the Zabbaleen district using structured interviews method.

7. Results

A summary of the factors and their overall priority scores is shown in Table 4. Factors with the highest priority score for each SWOT category in a particular stakeholder group are highlighted in bold, and the highest overall priority score is also highlighted in bold italic. For all comparisons, the CR was always less than 0.1. Following Masozera et al. (2006), the scores of strength and opportunity factors can be interpreted as positives while the scores of weakness and threat factors as negatives for the Zabbaleen urban development in Cairo. For example, the overall priority scores for strength and opportunities were 0.317 and 0.317 for population stakeholder group. The sum of priority scores was 0.634 implying that about 63% of the overall perception about the Zabbaleen urban development is positive for the population stakeholder group. The overall priority score of other stakeholder group can be interpreted in the same manner. The relative importance of each factor within each SWOT category provides valuable insights for decision-making.

Population:

The overall perception of Population stakeholder group regarding the development of el Zabbaleen district was equally determined by threats (31.7%), opportunities (31.7%) and strengths (31.7%). In particular, Population were concerned with one factors within the threats category, the lack of security. This factor explained 41.8%. of population perception regarding threats (Fig. 2). Opportunities were also significant in determining overall perception (13.7 %). The factors which got highest priorities within opportunities category were the ability to coordinate funding from government and community agencies (28.3%). Strengths received 31.7% of population perception. Weakness was not given much importance by this stakeholder group as strengths explained only 11.8 % of the overall perception.

NGOs:

The overall perception of NGO stakeholder group regarding the development of el Zabbaleen district was equally determined by opportunities (13.20%), and threats (29.7%). In particular, NGOs preferred one factors within the opportunity category, Community Participation. This factor explained 37%. of NGO's perception regarding opportunities (Fig. 2). Threats were the second most significant in determining overall perception (13.6 %). The factors which got highest priorities within weakness category were the unacceptable living conditions (38.5%). Weakness was not given much importance by this stakeholder group as strengths explained only 6 % of the overall perception.

Table (4) Summary of the priority scores of all SWOT factors and categories.

Factor Priority						**Overall Priority**					
	Pop	**Gov**	**NGO**	**Indus**	**Acd**		**Pop**	**Gov**	**NGO**	**Indus**	**Acd**
T1	0.008	0.096	0.131	0.188	0.074	T1	0.003	0.027	0.017	0.038	0.005
T2	0.222	**0.320**	**0.385**	0.113	0.182	T2	0.070	0.089	0.051	0.023	0.013
T3	**0.418**	0.088	0.103	0.173	0.209	T3	0.133	0.024	0.014	0.036	0.015
T4	0.158	0.226	0.188	0.222	**0.286**	T4	0.050	0.063	0.025	0.046	0.020
T5	0.194	0.270	0.193	**0.304**	0.249	T5	0.062	0.075	0.025	0.062	0.017
							0.317	***0.277***	***0.132***	***0.205***	***0.070***

Opportunities

	Pop	**Gov**	**NGO**	**Indus**	**Acd**		**Pop**	**Gov**	**NGO**	**Indus**	**Acd**
O1	0.166	0.251	**0.297**	0.089	0.195	O1	0.053	0.070	0.039	0.018	0.014
O2	**0.283**	**0.325**	0.213	0.183	0.220	O2	0.090	0.090	0.028	0.038	0.015
O3	0.141	0.101	0.143	0.185	0.220	O3	0.045	0.028	0.019	0.038	0.015
O4	0.126	0.095	0.105	**0.296**	0.110	O4	0.040	0.026	0.014	0.061	0.008
O5	**0.283**	0.228	0.242	0.246	**0.256**	O5	0.090	0.063	0.032	0.051	0.018
							0.317	***0.277***	***0.132***	***0.205***	***0.070***

Weakness

	Pop	Gov	NGO	Indus	Acd		Pop	Gov	NGO	Indus	Acd
W1	**0.294**	0.219	0.131	**0.300**	0.135	W1	0.093	0.061	0.017	0.062	0.009
W2	0.045	0.092	0.125	0.078	0.079	W2	0.014	0.025	0.017	0.016	0.006
W3	0.138	0.112	**0.139**	0.108	0.108	W3	0.044	0.031	0.018	0.022	0.008
W4	0.151	0.087	0.131	0.128	0.126	W4	0.048	0.024	0.017	0.026	0.009
W5	0.043	**0.141**	0.083	0.051	0.084	W5	0.013	0.039	0.011	0.010	0.006
W6	0.155	0.098	0.128	0.098	**0.156**	W6	0.049	0.027	0.017	0.020	0.011
W7	0.080	0.111	0.102	0.091	0.132	W7	0.025	0.031	0.014	0.019	0.009
W9	0.034	0.047	0.078	0.041	0.089	W9	0.011	0.013	0.010	0.008	0.006
W10	0.059	0.093	0.083	0.105	0.091	W10	0.019	0.026	0.011	0.022	0.006
							0.118	***0.136***	***0.063***	***0.079***	***0.039***

Strengths

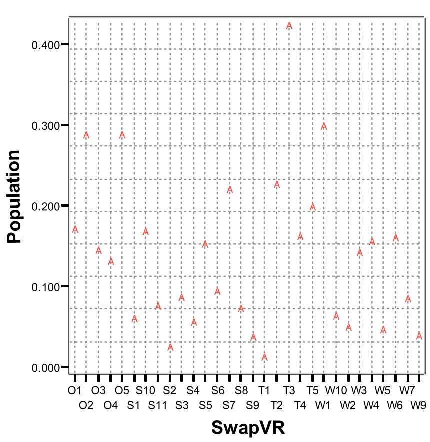
	Pop	Gov	NGO	Indus	Acd		Pop	Gov	NGO	Indus	Acd
S1	0.055	0.086	0.068	0.152	0.063	S1	0.018	0.024	0.009	0.031	0.004
S2	0.021	0.058	0.098	0.019	0.054	S2	0.007	0.016	0.013	0.004	0.004
S3	0.082	0.079	0.094	0.065	0.079	S3	0.026	0.022	0.012	0.013	0.006
S4	0.051	0.109	0.095	0.050	0.075	S4	0.016	0.030	0.013	0.010	0.005
S5	0.148	**0.198**	0.096	0.122	0.123	S5	0.047	0.055	0.013	0.025	0.009
S6	0.090	0.109	0.098	0.085	0.092	S6	0.029	0.030	0.013	0.018	0.006
S7	0.216	0.174	**0.112**	0.172	**0.179**	S7	0.069	0.048	0.015	0.035	0.013
S8	0.067	0.037	0.098	0.034	0.089	S8	0.021	0.010	0.013	0.007	0.006
S9	0.033	0.009	0.055	0.029	0.063	S9	0.010	0.003	0.007	0.006	0.004
S10	**0.164**	0.099	0.086	**0.215**	0.093	S10	0.052	0.027	0.011	0.044	0.007
S11	0.072	0.042	0.100	0.057	0.091	S11	0.023	0.012	0.013	0.012	0.006
							0.317	***0.277***	***0.132***	***0.205***	***0.070***

Government:

The overall perception of Government stakeholder group regarding the development of el Zabbaleen district was equally determined by threats (27.70%), opportunities (27.7%) and strengths (27.7%). In particular, Government stakeholders preferred one factors within the opportunity category, the ability to coordinate partnership between funding, development, government and community agencies. This factor explained 32.5%. of government perception regarding opportunities (Fig. 2). Threats were also significant in determining overall perception (27.7 %). The factors which got highest priorities within weakness category were the unacceptable living conditions (32.0%). Weakness was not given much importance by this stakeholder group as strengths explained only 13.6 % of the overall perception.

Industrialists:
The overall perception of Industrialist stakeholder group regarding the development of el Zabbaleen district was equally determined by opportunities (20.5%), and threats (20.5%). In particular, Industrialists preferred one factors within the opportunity category, Recognizing Alternatives to New, High-tech Solutions. This factor explained 29.6%. of Industrialists perception regarding opportunities (Fig. 2). Threats were also significant in determining overall perception (20.5 %). The factors which got highest priorities within threats category were the lack of services (30.4%). Weakness was not given much importance by this stakeholder group as strengths explained only 7.9 % of the overall perception.

Academia:
The overall perception of Academia stakeholder group regarding the development of el Zabbaleen district was equally determined by opportunities (13.20%), and threats (29.7%). In particular, NGOs preferred one factors within the opportunity category, Community Participation. This factor explained 37%. of NGO's perception regarding opportunities (Fig. 2). Threats were the second most significant in determining overall perception (13.6 %). The factors which got highest priorities within weakness category were the unacceptable living conditions (38.5%). Weakness was not given much importance by this stakeholder group as strengths explained only 6 % of the overall perception.



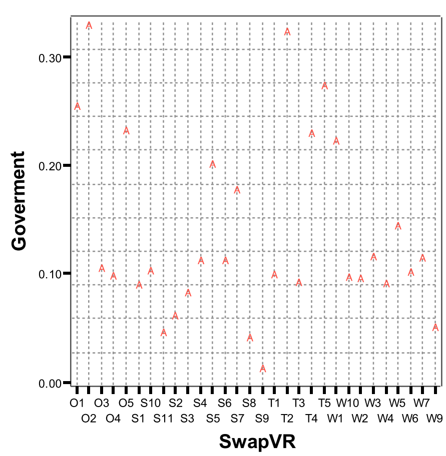


Figure (2) Perception of Population Group (left) and Government group (right)

8. Discussion and conclusions

The urban patterns in the Egyptian cities have been rapidly changing over the last three decades. This change was brought about by the dynamics of social and economic forces changing the face of cities and it is continuing to this day. The problem of transformation of urban patterns in Egyptian cities stems from different reasons. In order to help upgrading the quality of life found in the urban district including informal settlement, governments should coordinate with other stakeholders, invest in, promote, monitor and evaluate the education and skill development of women and girls and the legal and economic rights of women. They should do the same with all aspects of reproductive health, including family planning.

This paper investigated stakeholders' perception of urban development of one of Cairo's slum districts. It uses SWOT-AHP approach to assess the perceptions of five stakeholder groups regarding sustainability of urban development. The district was selected due to the existence of significant poverty rate, the potential role that the district will be a prototype for future development of other slum areas within Cairo. On an average, the overall perception for all stakeholder groups was equally determined by strengths (20.1 %), opportunities (20.1%) and threats (22%). Perception of Weakness was less than other categories (8.7%). Two threat factors were given the highest concerns by all stakeholder groups: the unacceptable living conditions and the lack of services. It was noted that the factor lack of security was highly perceived by Population stakeholders only. Among opportunities, all four stakeholder groups gave their highest priority to the ability to coordinate fund, government and community agencies, and partnership involving organization to fund projects. All stakeholders groups recognized high priorities to two strength factors: increasing the services capacity, and improving the sanitation.

The results of this study indicate that all four stakeholder groups are in favor of promoting urban development in El-Zabbaleen district. All the stakeholder groups have recognized that the Zabbaleen district urban development project has a great potential slum area development. Therefore, there exists a need to craft a suitable policy which can promote such a development in other slum areas by incorporating issues deemed important by various stakeholder groups.

9. References:

ABT Associates (1981), *The Informal Sector,* Main Report, USAID/Egypt.

Abu-Lughod, J (1971), *Cairo 1001 Years of the City Victorious*, Princeton University Press, Princeton New Jersey.

Assaad, R and Rouchdy, M (1998), *Poverty and Poverty Alleviation Strategies in Egypt*, the Ford Foundation, Cairo, January 1998.

CEDEJ (2002) (Centre de research et de documentation economique, juridique, et social) and the Participatory Urban.

Denis, E (1999), "Le Caire à l'orée du XXIe siècle: Une métropole stabilisée dans un contexte dedéploiement de la croissance urbaine", in *Lettre d'information de l'Observatoire Urbain*

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), (2003). Urban Upgrading Project – Manshiet Nasser. Available From: http://www.egypturban.net/Projects/ViewProject.asp?ProjectID=27 (Accessed 24 May 2004).

Dwivedi, P. & Alavalapati, J. (2009), Stakeholders' perceptions on forest biomass-based bioenergy development in the southern US, Energy Policy, Vol. 37, pp. 1999-2007.

Dyson, R.G., (2004). Strategic development and SWOT analysis at the University of Warwick. European Journal of Operational Research 153 (3), 631–640.

GOHBR, ABT Associates Inc., Dames and Moore, (1982). Informal Housing in Egypt.

Houben, G., Lenie, K., Vanhoof, K., (1999). A knowledge-based SWOT-analysis system as an instrument for strategic planning in small and medium sized enterprises. Decision Support Systems 26 (2), 125–135.

London Shorter, F (1989) "Cairo's Leap Forward: People, Households, and Dwelling Space", *Cairo Papers in Social Science*, Vol 12, American University in Cairo.

Management Programme (Ministry of Planning and GTZ), *Information System for Informal Development*, unpublished draft, Cairo.

Masozera, M.K., Alavalapati, J.R.R., Jacobson, S.K., Shrestha, R.K., (2006). Assessing the suitability of community-based management for the Nyungwe Forest Reserve, Rwanda. *Forest Policy and Economics*, Vol. 8 (2), 206–216.

Mollenhorst, H., de Boer, I.J.M., (2004). Identifying sustainability issues using participatory SWOT analysis: a case study of egg production in the Nether- lands. Outlook on Agriculture 33 (4), 267–276.

Nair, K.G.K., Prasad, P.N., 2004. Offshore outsourcing: a SWOT analysis of a state in India. Information Systems Management 21 (3), 34–40.

Nathwani JS, Lind NC, Pandey MD. (1997) Affordable safety by choice: the life quality method. Waterloo, Ont., Canada: Institute for Risk Research, University of Waterloo.

Osman, M and El Hakim (2000), S, *Public Finance for Upgrading Urban Informal Settlements – Existing Pattern and Better Management*, Institute for National Planning, Cairo, (unpublished memo)

Rodenbeck, M (1998), *Cairo The City Victorious*, Picador Press

Saaty, T.L., Vargas, L.G., (2001). Models, Methods, Concepts & Applications of the Analytical Hierarchy Process. Kluwer Academic Publisher, Dordrecht, Nether- lands.

Sims, D (2000), *Residential Informality in Greater Cairo: Typologies, Representative Areas, Quantification, Valuation,*

Szalai, A., (1980). The meaning of comparative research on the quality of life. In: Szalai, A., Andrews, F. (Eds.), "*The Quality of Life*". Sage Beverly Hills, CA, pp. 7–24.

The role of park planning in enhancing the quality of urban environments

Dr Ayman Hassan, Rania Roshdy
The British University in Egypt, Egypt

The significance of open spaces to our environment and quality of life is increasingly established. A number of studies on public facilities such as urban parks have been conducted in terms of their location standards, location methods, and relevance of their distribution. The development of environmental awareness has resulted in a strong demand by urban residents for green space for various purposes, including aesthetic enjoyment, recreation, and access to clean air or a relatively quiet environment. Amenity values attached to urban green spaces are non-market price despite their environmental benefits. In the absence of an explicit market price for a unit of environmental amenity, the benefits are usually ignored or underestimated by urban planning policy-makers, with the consequence that remnant urban green spaces have shrunk in size and have been gradually encroached upon by urban development and sprawl. This paper aims to investigate the relationship between urban park planning and the quality of urban environment. Additionally, it identifies design characteristics perceived in the Egyptian public parks. A quantitative system of inquiry was used in this research to investigate the contribution of the Azhar Park, Cairo - Egypt on surrounding districts. A questionnaire was conducted for collecting data. The contribution of the park on social, economic and transportation qualities of the surrounding urban districts was highlighted.

Keywords: environmental quality, sustainable development, urban sustainability

1 Introduction

Sustainable development is defined as “development that meets the needs of current generations without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987, p. 23). Stead and Stead (1996) identified six considered “fundamental values” of sustainability including wholeness, posterity, smallness, community, quality, and spiritual fulfillment.

The urbanized residential environment has become the main environment for people worldwide as United Nations’ Estimate (2005) reported that almost 50% of the world population dwelled in urban areas in 2005. The quality of residential environment in urban settings has consequently become a gradually more significant issue for residents in addition to other parties, for example urban planners and designers, city officials, and researchers. To enhance the quality of residential environments, urban planners and city officials have been motivated to carry out enhanced urban designs or make more effective policies; whereas researchers have been attempting to establish theoretical fundamentals of residential environment quality. The urban Quality of Life (QOL) conception achieved more importance as it is considered that the world population is predictable to reach someplace between 7.6&9.4 billion (Kennedy, 1993)

2 Measures of sustainability:

Quality of Life (QOL) is perceived as a major sustainability factor that fulfills the sustainable development of urban areas (Mitchell, 2000; Shafer et al., 2000). Operation measurement and indicators of urban sustainability defined in terms of adaptive and social learning are classified according to Ulengin et al (2001) into descriptive and analytic indicators. Descriptive indicators, that inform us merely the number of homeless individuals or the amount of greenhouse gases emitted from private vehicles, assume expert-based background and recognition of the best outline for understanding cause–effect associations and a dependence on experts to incorporate the new information and devise solutions. The role of the public accordingly occurs after the release of indicator results, and is restricted to the task of moving satisfactory political will to support the required action. Analytic indicators, by contrast, can only be resultant based on up-front work by the politic body to recognize and conceptualize a framework to propose how a problem indicated by a reported trend could be solved (Holden, 2006).

2.1 Quality of Life

Szalai (1980) defined Quality of Life (QOL) as the degree of excellence or satisfactory character of life. A person's existential state, well-being, satisfaction with life is determined on the one hand by objective facts and features of his life and on the other hand by the subjective perception and assessment he has of these facts and factors, of life and of himself. Raphael et al. (1996) defined "life quality" as the degree to which a person enjoys the important possibilities of his/her life. Shafer et al. (2000) extended the definition "life quality" to be "a community's ability to develop and/or maintain a high quality of life in the present in a way that provides for the same in the future" (Shafer, et al., 2000). It is agreed in literature that "Quality of Life" can be monitored and quantified in the form of "Quality of Life Index".

2.2 Quality of Life Index

The quality of life (QOL) index is a social indicator proposed by Nathwani et al.(1997) to reflect the expected length of "good" life, in particular the enhancement of the quality of life by good health and wealth. They tried to categorize the components of QOL and compared various geographical areas such as cities, states and nations by means of QOL indices that they developed (Liu, 1976; Boyer and Savageau, 1981; Sufian, 1993).

An important reason for such an interest in QOL lies in the question of effective distribution of inadequate resources (Megone, 1990). Given the inadequate resources, policymakers need to discover the most efficient way of distributing them corresponding to the requirements and the priorities of people. This can be achieved by using the results of the related research as input in the decision-making processes. In other words, such studies are the means of producing appropriate policy recommendations for authorities.

QOL is a multidisciplinary, hence a multidimensional concept (Wish, 1986). This is obviously seen in the studies summarised in Table 1, where QOL is admitted to have multiple components. Different results were obtained from studies on QOL due to: (1) the differences in the selected sets of variables; (2) the weighting scheme of the variables; (3) the approaches implemented; (4) the methodologies used; (5) the people that the data were gathered from; and (6) the homogeneity of the geographical analysis units that the research is based on.

As seen in Table (1), it is difficult to find the same attribute set in the literature. Though they have common attributes, they are rarely measured by the same units. The names of the attributes can be misleading in many cases. For example, as

Wish (1986) criticised Liu's results (Liu, 1976), as the latter measured his social attributes by 54 indicators, most of which are irrelevant from Wish's point of view. In addition, political and economic attributes have indicators in common with the social component, which leads to double counting, and to bias (Wish, 1986). Additionally, most studies suffer from the "ad hoc" weighting schemes of the attributes and/or variables. In most studies, the weighting process (either equal weights or not) is based on the researchers' judgment (see, for example: Liu, 1976; Boyer and Savageau, 1981). Wish (1986) compared two studies by Liu (1976) and Boyer and Savageau (1981), both of which compare SMSAs (Standard Metropolitan Statistical Area) in the USA, and calculates the Spearman's rank correlation as 0.08. Construction of a multidisciplinary conceptual framework of environmental quality and QOL is required to advance the field of urban development, environmental quality and human well-being. These tools are necessary to evaluate the current and future quality of the urban environment and also necessary to have, in the long run, the ability to evaluate the implications of spatial and urban planning policies with respect to these dimensions (van Kamp et al., 2003).

Table (1) QOL Indicators as reported in literature

Source	**QOL Attributes employed**
Liu (1976)	(1)Economic, (2)Political, (3)Environmental, (4)Social and (5) health & educational
Boyer and Savageau (1981)	(1)Climate, (2)Housing, (3)Health care & environment, (4)Crime, (5)Transportation, (6) Education, (7)Arts, (8)Recreation, (9)Economics
Blomquist et. al. (1988); Stover and Leven (1992)	(1)Precipitation, (2)Humidity, (3)Heating degree days, (4)Cooling degree days, (5)Wind Speed, (6)Sunshine, (7)Coast, (8)violent crime, (9)Teacher-Pupil Ratio, (10) Visibility, (11)Total suspended particulates, (12)NPDES effluent discharges, (13)Landfill waste, (14)Superfund Sites, (15)Treatment, Storage and disposal site, (16)Central City.
Sufian (1993)	(1)Public safety, (2)food cost, (3)Living Space, (4)Housing Standard, (5)Communication, (6)Education, (7)Public Health, (8)Peace & quiet, (9)Traffic Flow, (10)Clean Air.

Based on Table (1), the attributes maintained in the present study are the ones that can be operated by the authorities, since an important intention of this study is to make policy recommendations to the authorities. Thus, factors such as climate, pollution and humidity are excluded. The attributes were then grouped into four independent clusters, referred to as decision constructs or higher constructs, by the experts. The four constructs that are accepted to describe the QOL in a city are: (1) Social Environment (SE); (2) Economic Environment (EE); (3) Transportation and Communication facilities (TC) and (4) Physical Environment (PE). The numbers of attributes corresponding to each higher construct are, 3, 5, 2 and 8, respectively. Each of the attributes has two levels except one attribute with 3 levels in PE.

These urban planning visions were extensively reviewed by Smith et al. (1997) resulting in a summary of quality and need principles that an urban environment should fulfil. Important elements are liveability, character, connection, mobility, personal freedom and diversity. On the basis of this, an extensive list of physical form criteria was put together with respect to community quality. Examples of strong elements are open space areas, outdoor amenities and 'walkability', while the use of warm colours or the size of front lawns are given as examples of form criteria that have a weak relationship with community quality.

3 Urban Parks and Quality of Life

Urban sustainability and regeneration strategies mainly focus on man-made and built components of the urban environment. In comparison, awareness to the natural components and the green spaces of the urban structure is still inadequate. Low appreciation of green spaces is also reflected in the recent cuts in the maintenance of budget of several towns (Tyrvainen and Vaananen, 1998). It is argued, however, that urban parks and open green spaces are of a strategic importance for the QOL of any increasingly urbanized society. QOL issues are central to all the various definitions of a sustainable city. Aspects such as "amount of public green spaces per inhabitant", "public parks" and "recreation areas" are often mentioned as important factors to make the city liveable, pleasant and attractive for its citizens (Chiesura, 2004). The relation between urban parks and city sustainability is addressed through the investigation of the value of urban nature as provider of social services essential to the quality of human life, which in turn is a key component of sustainable development. Fig. 1 illustrates the conceptual links and relationship assumed between urban park and city sustainability.

Increasing empirical evidence indicates that the presence of natural assets (e.g. urban parks, forests and green belts) and components (e.g. vegetation, topography and water) in urban contexts contributes to the QOL in many ways. In addition to important environmental services such as air and water purification, wind and noise filtering, or microclimate stabilization, natural areas provide social and psychological services, which are of vital significance for the livability of modern cities and the well being of urban inhabitants.

The hypothesis about the restorative function of natural environments has been tested in several empirical studies. Investigations on the use of urban parks and forests, for example, verified beliefs about stress-reduction benefits and mental health (Conway, 2000). In a survey among park's visitors a significant correlation was found between use of the parks and perceived state of health: those who used local parks regularly were more likely to report good health than those who did not (Godbey et al., 1992). A park experience was found to be reducing stress (Ulrich, 1981), additionally it may enhance contemplativeness, revitalize the city dweller, and provide a sense of nonviolence and tranquility (Kaplan, 1983).

Schroeder (1991) has shown that natural environments with vegetation and water induce relaxed and less hectic states in observers compared with urban scenes with no vegetation. This ability of natural elements to function as "natural tranquillizers" may be particularly beneficial in urban areas where anxiety and stress are too common aspects of daily living. Nature can encourage the use of outdoor spaces, increases social integration and interaction among neighbors (Coley et al., 1997). The presence of trees and grass in outdoors common spaces may encourage the development of social ties (Kuo et al., 1998). Kuo et al. (1998) also found out that greenery assists people to relax and renew, reducing aggression. Natural environments can also be seen as a domain of active experience providing a sense of challenge, privacy and intimacy, aesthetic and historical continuity. Furthermore, aesthetic, historical and recreational values of urban parks increase the attractiveness of the city and promote it as tourist destination, thus generating employment and revenues. Furthermore, natural elements such as trees or water increase property values, and therefore tax revenues as well (Luttik, 2000).

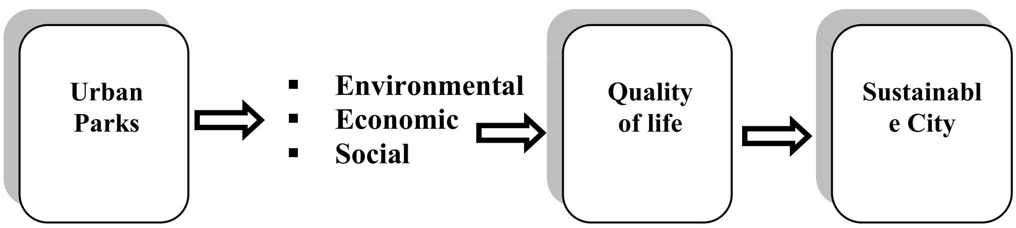


Fig. (1) The Relationship between Urban Parks and Quality of Life

The purpose of this paper is to explore the relationship between physical design of urban parks, represented in people perception of its physical elements and the QOL attributes that express the needs of the inhabitants of a selected neighbourhood in Old Cairo, Egypt. Fig. 2 illustrates the hierarchical structure and attributes of the each construct of the QOL model used in this study.

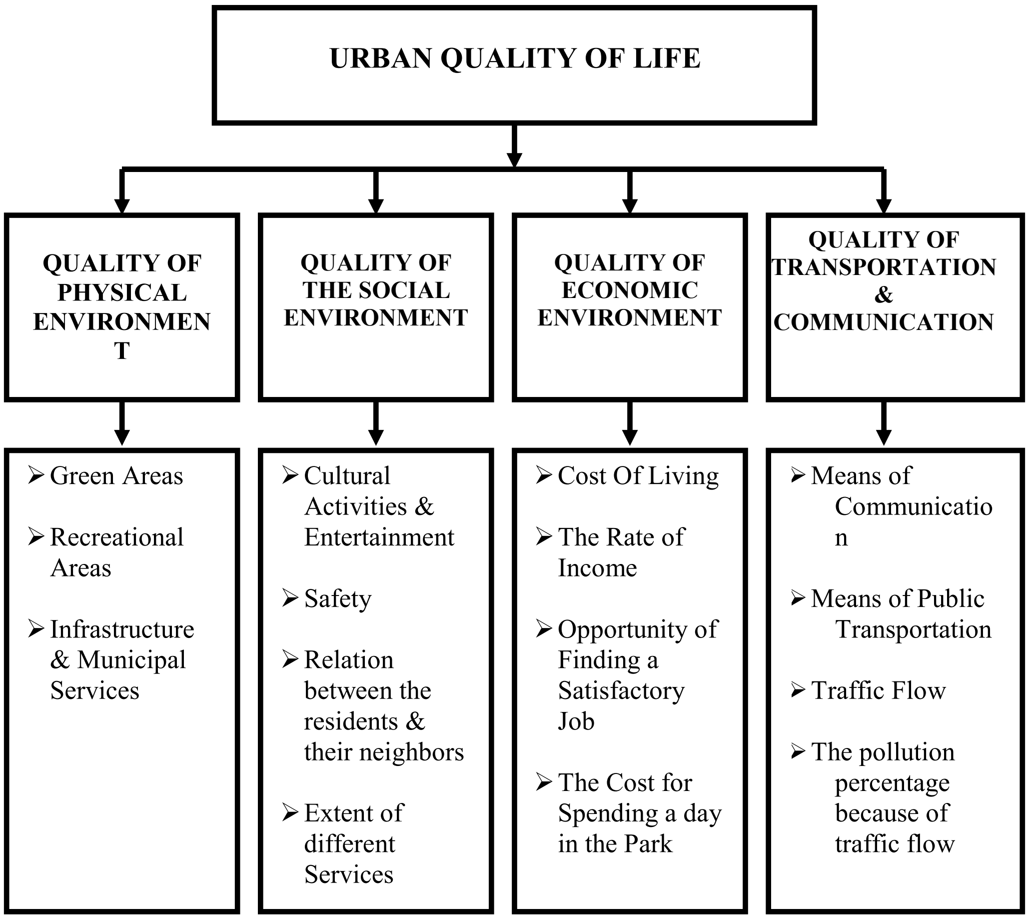


Fig. (2) Structure of QOL and attributes used in this study (Ulengin et al., 2001)

4 Method

4.1 Subjects

A total of 36 residents were participated in QOL structured interviews during November 2008. The participants were randomly selected from the visitors of the

Park in different days of the week. The distributions of their social and demographic characteristics, such as gender, age, marital status and education level of residence in El-Darb El-Ahmar district, Cairo, are shown in Table 2.

Table (2) Social and Demographic characteristics of respondents

GENDER		AGE		EDUCATION	
Type	Percentage	Range	Percentage	Education level	Percentage
Male	81.82%	Below 20	12.12%	Uneducated	36.36%
		20-29	27.27%	Basic	30.30
Female	18.18%	30-39	12.12%	Secondary	3.030
		40-49	15.16%	Technical Education	12.13
		Above 50	33.33%	Higher Education	18.18%

4.2 Study Area

The Azhar Park is one of the largest parks in Cairo, Egypt, which is located in Darb al-Ahmar district in the core of "Fatimid Cairo" that was established in the 10th century AD by the Fatimid Caliphate. The current urban character of the district is a medieval organic tissue of narrow alleys lined with teetering shacks, strewn with rotting garbage, and prowled by ruthless drug dealers, was until recently one of this city's most ghastly and disreputable slums with about 30 square centimeters of green space per resident. The Azhar Park project was conceived of twenty years ago by the Aga Khan Trust for Culture (AKTC). The concept was to create a park as a gift to the city of Cairo - Egypt, which was originally founded by the Aga Khan's ancestors of the "Fatimid caliphs". It was funded and constructed by the AKTC through its Historic Cities Support Programme.

The park was designed to act as the much-needed "lungs" of a metropolis that had less than a footprint of green space per person (Bianca, 2005). The AKTC first laid foot on the area more than 10 years ago when the work at the 30-hectare Al Azhar Park started. In addition to serving as a "green lung" to the city, the park has become a catalyst for the revitalization of the neighbouring Darb Al Ahmar district and it's over 200,000 inhabitants (see Fig. 3 & 4). Due to size and centrality, the Azhar Park is expected to fulfill a vital function in expanding park and green space available to the public in Greater Cairo, the population of which stood close to 16 million in 2000. It is anticipated that the Park will attract visitors from other regions as well. Total annual number of visitors is projected to reach as many as 1.5 million in the initial years.

Fig.(3) Arial View of the Azhar Park and the surrounding district (Source: snap shot from Google Earth)


Fig. (4) The setting of the Azhar Park with relation to El-Darb El-Ahmar district

4.3 Equipment

Questionnaire design:

A residential environment quality questionnaire was devised. The questionnaire consisted of two parts. The first part included four questions corresponding to personal characteristics of subjects including: gender, are, education, career, familiarity with the district and number of visits of the urban park. The second part included 18 questions, corresponding to the key-concepts retrieved from the QOL indices reported in literature described in section 3.2, specifically Ulengin et al. (2001), including: (1) Social Environment (SE); (2) Economic Environment (EE); (3) Transportation and Communication facilities (TC) and (4) Physical Environment (PE). Each question is a statement that concerns either positive or negative features of the neighbourhood, house, or neighbours. Respondents were asked to indicate how closely each statement described their residential environment with a ten-point scale, from 'totally agree' (10 points) to 'totally disagree' (1 point). For example, a question concerning SE was formulated as: "*How much do you feel safe in the area surrounding the park?*" Finally, these items were randomly ordered in the questionnaire in hopes of eliciting more objective answers from the respondents.

4.4 Procedures

The questionnaire was set up and respondents were randomly selected among the visitors of the park, regardless of their social extraction or professional background. People approached in the park, were first informed about study objectives and answering procedure. Those willing to participate voluntarily were given the questionnaire and invited to fill it in during their stay at the area, so that the answers would reflect their immediate experiences. Questionnaires have been distributed on both weekdays and weekends, in different hours of the day, and in different zones of the parks.

5 Results

Data gathered from 36 surveyed respondents were first encoded. The whole data set was then divided into four data subsets, corresponding to four scales of urban environment quality: Physical Environmental Design (PE), Social Environment (SE), Economic Environment (EE) and Communication + Transportation (CT). In order to explore the pattern of relationships between PE and other QOL attributes, statistical software SPSS 10.0 was used to perform Spearman Brown Correlation Test on collected data. Table (3) summarizes the results of this test. This test revealed significant correlation between PE attributes and most social attributes. Economic attributes were rarely correlated to PE attributes. Only "job opportunities" was significantly correlated to "layout efficiency", "plants' pattern" and "nodes". While there was a significant positive correlation between "land value" and "commercial value"and few PE attributes including "pathway design" and "nodes". Communication and Transportation attributes were significantly correlated to "layout efficiency" only.

Table (3) Results of Spearman Correlation Test between Physical Design and other QOL attributes

	Social				***Economic***					***Communic. + Transport.***	
Physical Design Attributes	*Familiarity*	*Freq. of visits*	*Safety*	*Socializing*	*Cost of ent.*	*Financial benefits*	*Job Opp.*	*Land Value*	*Commercial Value*	*Access.*	*Transpor.*
Layout efficiency	-.268	.347*	.400*	.362*	-.269	-.018	.456*	.281	.249	.326	.404*
Plants' Patterns	-.175	.403*	.546*	.333	-.066	-.015	.530*	.245	.167	.154	.247
Distributio n f Ent.	.095	.372*	.601*	.142	.084	.138	.251	.370*	.310	.033	.108
Pathway design	-.367*	.442*	.192	.502*	-.325	-.034	.408*	.460*	.347*	.220	.200
Signage	-.341	.347*	.477*	.350*	-.311	-.124	.296	.320	.237	.070	.250
Nodes	-.284	.506*	.505*	.372*	-.243	-.001	.635*	.433*	.367*	.324	.228
Coherence	-.356*	.515**	.398*	.237	-.024	.263	.296	.114	.198	.182	.256

* $p < 0.05$ ** $p < 0.01$

Statistical software SPSS 10.0 was used to conduct Principal Component Analysis (PCA) on each data subset to extract the major factors of the corresponding scale by employing the Varimax Orthogonal Rotation method. Factors were extracted by using the 'screen test' and a factor interpretability criterion. Items with factor loadings less than 0.4 in either factor or exhibiting high factor loadings in more than one factor were eliminated. For each extracted factor, items consistently with Cronbach's α index below 0.35 (indicating a lack of internal consistency among items) and eigenvalue below 1.0 were also eliminated. As a result, four out of the 45 items were eliminated, and eleven major factors were identified.

- **Scale 1: Security and Social Environment (SE)**

In the 'Security and social relationships' scale, four factors with a total explained variance of 68.46 % were extracted.

Factor 1: Two item, concerning frequency of visits and sense of safety, were loaded on this factor (α = 0.636).

Factor 2: One items, concerning socializing with neighbors, were loaded on this factor (α = 0.393).

Factor 3: One item, concerning frequency of visits, was loaded on this factor (α = 0.393).

- **Scale 2: Economic Environment (EE)**

In the ‘economic benefits’ scale, four factors with a total explained variance of 68.46 % were extracted.

Factor 3: Two item, concerning job opportunities, were loaded on this factor (α = 0.48).

Factor 4Two items, concerning increased land value and commercial value, were loaded on this factor (α = 0.88).

Factor 5: One item, concerning financial benefits from visitors, was loaded on this factor (α = 0.82).

Factor 6: One item, concerning cost of visit, was loaded on this factor (α = 0.90).

- Scale 3: Communication + Transportation (CT) to the park

In the ‘accessibility to the park’ scale, one factors with a total explained variance of 68.46 % were extracted.

Factor 7: Two items, concerning pedestrian accessibility and transportation availability, were loaded on this factor (α = 0.80).

- Scale 4: Physical Environmental design of the park (PE)

In the ‘landscape design of the park’ scale, four factors with a total explained variance of 68.46 % were extracted.

Factor 8: Six item, concerning layout efficiency, labeling of plants, entrance distribution, signage, availability of nodes, increased sense of belonging, were loaded on this factor (α = 0.75).

Factor 9: Two items, concerning entrance distribution, and congestion, were loaded on this factor (α = 0.60).

Factor 10: Two item, concerning congestion and increased sense of belonging, was loaded on this factor (α = 0.41).

Factor 11: One item, concerning distribution of entrances, was loaded on this factor (α = 0.90).

Multidimensional scaling using ALSCAL model was applied and data were plotted in order to graphically represent the distinctive grouping of attributes. This analysis was important to explore the configuration of attributes represented in two-dimensional Euclidean Space. The test revealed that attributes from 4 scales were grouped in 3 major sub-sets (Fig. 5). This analysis revealed that some PE attributes were closely influencing other SC, EE, CT attributes. In the first sub-set “entrance location” was grouped with “safety” and “belonging”. In the second sub-set, most PE attributes were grouped together with one important EE attribute that is “job opportunities”. In the third sub-set, EE attributes were closely influenced with TC attributes.

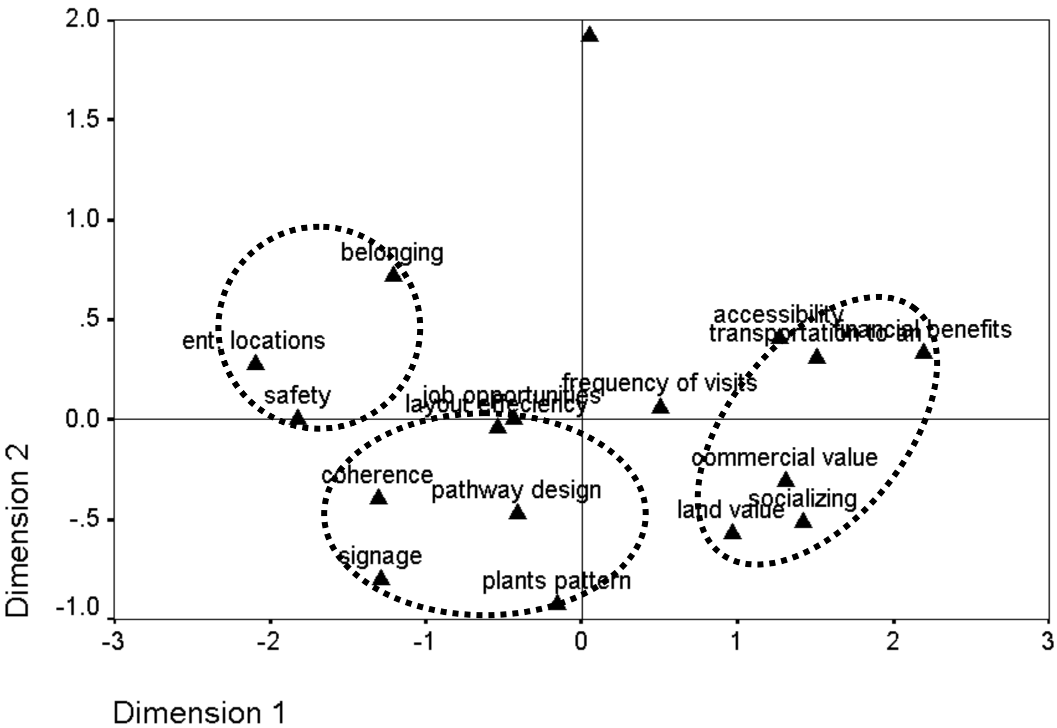


Fig. (5) Results of ALSCAL Multidimensional scaling of QOL attributes. Sub-sets are highlighted in dotted closed curves.

6 Discussion

The aim of this paper was to explore how urban parks can contribute to the QOL of urban environment. Theoretical framework was established based on previous research. This framework hypothesized that PE attributes of urban parks are likely to enhance the QOL of urban environments. The results of this study were consistent with previous investigations. The PE of the selected study area was significantly correlated to important QOL attributes in 3 scales: Social Environment, Economic Environment, Communication + Transportation Environment. Analysis of results revealed significant correlation between PE and other QOL attributes. Sense of "safety" and "belonging" was significantly influenced by layout and distribution of entrances that link the Azhar Park with El-Darb El Ahmar district. These entrances were considered as gateways of residents to visit the park. Additionally, results revealed that PE contributed significantly to economic environment of the district in terms of increased job opportunities of residents.

The substantive conclusion of this study is that, on average, respondents perception of QOL of their district was enhanced due to the advent of the Azhar Park. This project provided a high opportunity of finding satisfactory jobs, adequate infrastructure and municipal services, rapid traffic flow and increased commercial values that contribute to their income. Thus, the city planners and municipal authorities should place the most emphasis on such projects in similar areas. This finding is consistent with Ulengin, B. et al. (2001). Of course, some of the attributes cannot easily be manipulated, but this study indicates the priorities to allocate resources to improve the QOL in similar districts of the old core of Cairo.

References

Bianca, S. (2005). Azhar Park: A Jewl in Historic Cairo. 'Topos', Volume 52, p.89.

Boyer, R., Savageau, D., (1981). "Places Rated" Almanac. Rand McNelly, Chicago.

Chiesura, A. (2004), The Role of Urban Parks for The Sustainable City. 'Landscape and Urban Planning', Volume 68, pp. 129–138

Coley, R., Kuo, F., Sullivan, W., (1997). Where Does Community Grow? The Social Context Created by Nature in Urban Public Housing. 'Environment and Behavior', Volume 29, pp. 468–494

Conway, H., (2000). Parks and people: the social functions. In: Woudstra, J., Fieldhouse, K. (Eds.), "The Regeneration of Public Parks".

Godbey, G., Grafe, A., James, W., (1992). The Benefits of Local Recreation and Park Services. A Nationwide Study of the Perceptions of the American Public. College of Health and Human development, Pennsylvania State University, Pennsylvania.

Holden, M. (2006), Urban indicators and the integrative ideals of cities, 'Cities', Volume 23, issue 3, pp. 170–183

Kaplan, R., (1983). The Analysis of Perception via Preference: A Strategy for Studying How the Environment Is Experienced. 'Landscape and Urban Planning', Volume 12, pp.161–176.

Kennedy, P., (1993). "Preparing for the Twenty-First Century". Random House, New York.

Kuo, F.E., Sullivan, W.C., (2001). Environment and crime in the inner city. Does vegetation reduce crime. Environment and Behavior. Volume 3, pp.343–367.

Liu, B.C., (1976). "Quality of Life Indicators in US Metropolitan Areas: A Statistical Analysis". Praeger, New York

Luttik, J., (2000). The value of trees, water and open spaces as reflected by house prices in the Netherlands. Landscape and Urban Planning, Volume 48, pp. 161–167.

Megone, C., (1990). The quality of life: Starting from Aristotle. In: Baldwin, S., Godfrey, C., Propper, C. (Eds.), "Quality of Life: Perspectives and Policies". Biddles, London, pp. 28±41.

Mitchell, G., (2000). Indicators as tools to guide progress on the sustainable development pathway. In: Lawrence, R.J. (Ed.), "Sustaining Human Settlement: A Challenge for the New Millennium". Urban International Press, pp. 55–104.

Nathwani JS, Lind NC, Pandey MD. (1997) Affordable safety by choice: the life quality method. Waterloo, Ont., Canada: Institute for Risk Research, University of Waterloo.

Raphael, D., Renwick, R., Brown, I., Rootman, I., (1996). Quality of life indicators and health: current status and emerging conceptions. 'Social Indicators Research', Volume 39, pp. 65–88

Schroeder, H.W., (1991). Preferences and meaning of arboretum landscapes: combining quantitative and qualitative data. 'Journal of Environmental Psychology', Volume 11, pp. 231–248.

Shafer, C.S., Koo Lee, B., Turner, S., (2000). A tale of three greenway trails: user perceptions related to quality of life. Landscape and Urban Planning, Volume 49, pp. 163–178.

Shafer, C.S., Koo Lee, B., Turner, S., (2000). A tale of three greenway trails: user perceptions related to quality of life. 'Landscape Urban and Planning', Volume 49, pp. 163–178.

Smith, T., Nelischer, M., Perkins, N., (1997). Quality of an urban community: a framework for understanding the relationship between quality and physical form. Landscape Urban Planning, Volume 39, pp. 229–241

Stead, W E and Stead, J G (1996) "Management for a Small Planet: Strategic Decision Making and the Environment", second ed. Sage, Thousand Oaks, CA

Szalai, A., (1980). The meaning of comparative research on the quality of life. In: Szalai, A., Andrews, F. (Eds.), "The Quality of Life". Sage Beverly Hills, CA, pp. 7–24.

Tyrvainen, L., Vaananen, H., (1998). The economic value of urban forest amenities: an application of the contingent valuation methods. Landscape and Urban Planning, Volume 43, pp. 105–118.

Ulengin, B.; Ulengin, F. & Guvenc, U. (2001), A multidimensional approach to urban quality of life: The case of Istanbul, 'European Journal of Operational Research', Volume 130, pp 361-374

Ulrich, R.S., (1981). Natural versus urban sciences: some psycho-physiological effects. Environment and Behavior, Volume 13, pp. 523–556.

United Nations, (2005). "World Population Prospect". Retrieved from http://esa.un.org/unup/.

van Kamp, I. et al. (2003), Urban environmental quality and human well-being Towards a conceptual framework and demarcation of concepts; a literature study Landscape and Urban Planning, Volume 65, pp. 5–18

Wish, N.B., (1986). Are we really measuring the quality of life? Well-being has subjective dimensions, as well as objective ones. American Journal of Economics and Sociology Volume 45, 93-99.

World Commission on Environment and Development (1987) "Our Common Future". Oxford University Press, Oxford.

Second Egypt and sustainable future: challenges?

Prof. Ahmed Rashed, Islam Abohela
The British University in Egypt, Egypt

In Egypt sustainability became a fashionable word in different fields, when in reality it is a concept of multidisciplinary issues. To write the history of sustainable future there are different scenarios and approaches. The participation of all parties is a must; the government, the private sector, donors, consultant bodies and the community with democracy approach one dimension. Over population, limited resources, building capacity, service upgrading and living in desert are other dimensions of challenges. Many ideas, initiatives, conferences, and studies were/are proposed for the Egypt's future scenarios. Egypt-Cairo 2050 (the National party), the developmental corridor (Prof. El Baz proposal), and others realistic or optimistic studies are on dialogues between supporters and rejecters of each. One of the main hypotheses of this paper is that the challenge to achieve sustainable future in Egypt is not the lack of ideas and studies but to have generations whom could be responsible to build such future. Therefore, this paper will concentrate on the role of architectural engineering and urban planning studies within the centre of sustainability and future studies at the British University in Egypt as an experiment to build the history of sustainable future in Egypt. Second Life is a virtual world on the Internet in which "residents" create an identity, meet people, buy land and build their own environment or purchase an existing one idea. The idea of Second Egypt is to have the Real World – Simulated sustainable future of Egypt through games such as the SimCity, scenarios of science fiction films, graduation projects and post graduate studies.

Keywords: desert, development, sustainability assessment, virtual city, Egypt

1 Introduction:

Prospective studies and the future of Egypt isn't just a theory, it is the issue of a generation that must be thinking and working hard to take its responsibility towards future generations. Over the years a variety projects of national trends started with optimistic expectations and ended with limited results or frustrations. It is noteworthy that Egypt has lots of potentials based on its civilization and its human resources. However these potentials should be efficiently implemented without the old way of try and error which consumes both energy and time. Our approach to achieving a better future for Egypt should be through the keen implementation of its resources through a modern well organized plan based on the cooperation between all sectors in the country, having a main target of achieving a developed country based on sustainable strategies.

Recently, the vision of the respectful scientist Farouk El-Baz, and the proposal of "Developmental Corridor" emerged as a developmental ideology which looked at the Western Desert as a site, and looked at science and youth as a way to achieve the goal.

Previously, Toshka project was a national project for which the government capacities were enhanced to be active. The question here is: during desert invasion and making new settlements in the desert, how is it possible to invest the opportunities and what are investment opportunities? Will heading towards the desert result in a better future for Egypt?? Or those visions and steps will drain current and future potentials. How about the scientific and practical studies used in the process of decision making, were they realistic? Are these decisions and steps coping with the rates and speed of change, the stage of globalization, and consequently its economic, social and political changes? Regardless of the controversy between the conservative and devout, and pros and cons, the question arises: Could Egypt grow in the old valley alone leaving 95% of the area pending? And what would happen after a quarter-century without heading towards the desert? The answer is that Egypt may have the time to ask, and as time passes, there will be no room for question, meanwhile desert will be a necessity for the future of tomorrow, and it won't just be perceived as new land to be added to the globe or a renaissance project that accommodates various fields of productive and service activities or a tool to restore balance to the map of Egypt from the urban population and economic point of view, but in addition to that, a row vast space for construction, management, and investment according to new rules with unrestricted spatial chains. This should be achieved through modern technology and the support of a rapidly growing visions and ideas and with the inspiration of the inherent cultural features. Accordingly heading towards the desert and the future of Egypt could not be left to the forces of spontaneous or historical coincidences, with the emphasis that the thought of the old valley with its problems and ills doesn't suit the future of the new society. Also, if the Egyptian architect play his role in formulating the future of Egypt, others will be in charge of this task, but with a major difference, which is charting the future of Egypt according to their interests, and because we live today on the legacy of parents and grandparents, it is our responsibility to examine what can our children and grandchildren inherit from us. The architect responsibility is a must at this stage, and he can not abdicate his role and his leadership in creating Second Egypt within the challenges of sustainability.

2 Research Hypotheses:

- The need for futuristic visions and programs combining the present and future of Egypt that would provide practical scenarios rather than setting unreachable plans.
- Prediction in the midst of regional and global variables as well as scientific revolutions is very difficult. Studies of the future depend on the thought (the survival of the fastest) which means who is the first to reach scientific and technological applications that would change the face of the world.
- The issue of population and resources is a strategic issue to be considered in the long term, and therefore getting out from the 5% of the Nile Valley and spreading to other areas either the Developmental Corridor or Toshka is a major development of resources.
- The desert and Egypt of the future need a construction, not only new in its version, but also new in its philosophy of development.
- The responsibility of the architect stems from his message of reconstructing the land, and the attempt to change the future and sustainability of the development of Egypt of tomorrow through work and out of equal competition so that self building and implanting moral and ideological values and self education of the items of sustainable environment could be achieved concurrently with technical components.
- Ethical, religious, artistic and architectural values of the heritage of ancient environments and what they contain of ideas, solutions and lifestyle compatible with the environment and not the desire to return to the past is the justification for deducting a futuristic architectural way of thinking of a sustainable development.
- Dialogue and studies that discuss issues of reconstructing the future of Egypt and the future of today's children, men and women of tomorrow, will not bring any new ideas through the traditional routine and therefore the emergence of new ideas that may be in some cases non-stereotypical is essential.

3 The Problem: Invading or settling in the desert:

The ironic note that the ratio of the population of the Egyptian desert to the total population of Egypt is the same percentage as the Nile Valley area to the total area of Egypt helped in promoting the idea of invading the desert. Gamal Hamdan, in his book "Egypt Personality" a study of the genius of the place" about the invasion of the desert says:

" It is not easy, howeve, to invade the desert, because it is not a geographical or cultural picnic, but it is a struggle against nature and a real battle against the element. The process may take the risk failures and setbacks as much as possibilities of success. It is regrettable that the first three attempts to reclaim and reconstruct desert lands in the last two or three decades (this meant 1950s, 1960s and 1970s of the past century), whether on the edge of the valley itself or in the oases, Al-Natroun Valley and they are the project of El-Tahrir Directorate, and the New Valley. They stumbled by varying degrees, and got many losses and did not achieve the desired or remarkable success."

The research here refers to the development of the desert as the *invasion of the desert.* This term was also found in many of the scientific and cultural circles, and in this regard we point out that we have to change the concepts of developing the desert as well as the requirements necessary for this development. Therefore, we found that it's necessary for us to change the operative word if the goal is to change the requirements of its significance. As the word invasion origin is (invaders), which means that the settlement is illegal with reparation of force and coercion.

The aim of invading a place is to deplete the resources and potential wealth in the desert, whether agricultural or mineral depending on a limited source of water and eventually leaving the place once the stock and resources are depleted. It is noticed that in Islamic history, the word *Conquest* was used instead of *Invasion* because the goal was not only to reconstruct the land, but also this reconstruction should be sustainable. Therefore, the actual meaning and significance of moving towards the desert is to develop and sustain it through making settlements and social communities.

After all, the old word (*Conquest)* enhances the concept of sustainable development and the deliberate settlement and the way of dealing with the desert environment from the perspective of coexistence, and not based on the ideology of invasion that will neglect any sustainable aspect. Changing the way of thinking will have a direct impact on the way we deal with the desert resulting in a developed sustainable second Egypt.

4 The Desert and the Strategic Environmental Assessment:

“Strategic Environmental Assessment” (SEA) can be defined as the process of a preliminary environmental assessment of the general objectives of the development related to major projects in the stage of setting Policies, Plans and Programs(PPPs) of these projects so as to ensure the environmental feasibility of these policies, plans and programs1. We find that to achieve a kind of developmental integration on the national, regional and local levels for settling in the desert from the environmental perspective there should be a "Strategic Environmental Assessment" to be the first steps to change the concept of the desert invasion to become desert development, and then laying the foundations and the basic principles of the desert development which is considered as an initial phase of decision making, completed by the Environmental Impact Assessment of the projects (EIA) which comes in later stages to ensure the integration of projects at various levels and the sustainability of the aimed development. Here, we must point out the four elements concerned with the raised environmental issue about settling in the desert: firstly, the population and what is related to this element regarding spatial issues, water, energy, food and other requirements. Secondly: the technical contents such as the food production techniques, disposal of waste, industry, energy and other methods of coexistence with the environment and affecting it. Thirdly: consumption; which is the ability of all parties to participate in the environmental benefit of the resources available which include water resources, agricultural lands, riches mineral and even the air itself. Fourthly and lastly: sustainability and networking which is the ability to build systems of land use and to exploit the riches that would attain environmental balance without

1 - Wood, C.: Environmental Impact Assessment: a Comparative Review, Longman Group Ltd., Harlow, Printed in Malaysia, First Published 1995, p 266.

draining them2. Therefore, the objective of assessing the environmental strategy is to make an attempt to ensure the sustainability of the aimed development and perform comprehensive studies of all aspects of desert development.

There is no doubt that the availability of information and different studies and the use of satellite images and geographic information systems (GIS) is the central axis and the cornerstone of the success of the presumed objectives of the "Strategic Environmental Assessment", in order to support the decision makers to take the right decisions. This may require rearranging and making comprehensive regulation for all institutions and bodies concerned with these studies, as well as to renew and reconcile all laws and legislation governing these fields.

5 Second Egypt and the future between Developmental Corridor and the Document of the twenty-first century:

It was mentioned in the document of the twenty-first century with regard to some of the questions dealing with the project of developing Southern Egypt.

"*Like any new project that must be accompanied by an emotional outburst tends to exaggerate optimism and an opposition tends to dump in pessimism, and between these two parties comes a confident mentality, which begins questioning whether Egypt is able to operate and grow in the old valley alone, leaving 95% of the area unused? What can happen without a large comprehensive project outside the valley, after a quarter century, for example?*"

On the other hand, Farouk Al-Baz suggested in his article in September 2005 "the Developmental Corridor" in the western desert as a means to secure the future of coming generations in Egypt.

"*This article stresses a proposal I made years ago to establish a road with world specifications in the Western Desert of Egypt that extends from the Mediterranean coast in the north to Lake Nasser in the south, at a distance ranging between 10 and 80 kilometers west of the Nile. This path opens up new prospects for the urban, agricultural, industrial and commercial extension within a distance up to 2000 kilometers. And because Egypt is in a great need for a way out of the difficult social situation at the present time in particular, I repeat presenting this proposal to be considered seriously, and perhaps to be implemented by investors' funds from the private national sector first then the Arab sector and third by the world sector*".

Whether it is the proposal of the document of the century, Toshka, or the Developmental Corridor, it is noticed that the fundamental objective is: "The creation of a new valley extending along the old valley to accommodate the

---

2 - Marsh, W. and Grossa, Jr., J.,: Environmental Geography: Science, Land Use, and Earth Systems, John Wiley & Sons, Inc., USA, 1996, p 7.

iii - Alganzory, K.: "Egypt and the Twenty First Century, Egypt's prime minister, Al-Ahram Alektesady book, issue 114, July 1997, p12.

iv - Albaz, F.: The Develpmental Corridor in the Western Desert as a Means for Securing the Egyptian Future Generations, Al-Ahram Newspaper, 3 September 2005.

v - Dabos, S.: With the Turn of the Century; President Mubarak's Gift for the Children, Akhbar Al-Yoom Newspaper, 27 November 1999, p14.

aspirations of future generations." In a serious attempt to correct the huge imbalance in the pattern of investment and population; here we have to ask: How, when and who are the settlers of Egypt the future? We find that today's children and the grandsons of tomorrow are the targets. The blending of science with imagination is the resort of the politicians and philosophers to manufacture the future and change our current reality, on the other hand, science has its fixed bases, but imagination must extend to what we call the (non-searched) or (non-handled).We can see that the difficulties are in the field of futuristic research in Egypt, although not quite recent, but what has been accomplished was small in number and at long intervals, and most of the time it has to be stopped before being completed. Hence, a large heritage was not accumulated for future research for those who needed a reference.

In our thinking for the future of Egypt, we pose the question? What would have happened if Nouh had not made his ship before the great drowning? Has there been any sort of life on earth? The issue here: how will our children live? What is waiting for us in the near future? Future studies require a knowledge base to help choose a better future for Egypt. This knowledge base is composed of two parts, first part: education, self building, understanding of the technicalities and the speed of change, which could create alternative perceptions for the reconstruction of Egypt's desert in various fields, the so-called scenarios, and the second part: an assessment of the benefits and costs of each scenario and it's sustainability.

From this perspective, the first phase for the visions of different scenarios requires a focus on the process rather than rushing the quality of the product, which acted as a cause of failure of previous attempts, which were related to governments or individuals rather than being a popular project which is the aim of Farouk Al Baz in his proposal as he says:

"*It would be nice if the broadest possible spectrum of people take part from the first moment. For example, each governorate could start preparing a list of development projects and its priorities based on its real needs and its necessary technicians and other capabilities. At the same time, it is a must not to get a foreign labour to work on the project, whatever the reasons, because the Egyptian (male or female) can be trained to do any work with the highest level of world performance. Also, university students can be encouraged through competitions to select development projects that can be done in their governorate. Even school students can participate through competitions to select the names of roads, towns and villages, which will be established on the sides of their governorate. The participation of young people is extremely important because the goal of the project is to secure their future by creating job opportunities for them infinitely*".

So, Farouk Al Baz vision was different from what happened in the past and his role was to plant the seed represented in the proposed project to turn it into a popular one and not attached to a government or some individuals or for a specific time, but would be a way of life through the partnership of all parties, The proposal must be examined by everyone, its issue and target should be informed to everyone, youth and media should play a key role in the study stage.

---

vi - Almaraghi, M.: Imagination and Making the Future, Al-Ahram Newspaper, 18 November 2003.

vii - Albaz, F.: The Develpmental Corridor in the Western Desert as a Means for Securing the Egyptian Future Generations, Al-Ahram Newspaper, 3 September 2005.

viii - http://www.mwri.gov.eg/toshka

In light of the emphasis on the aimed steps or reconstruction process rather than focusing and accelerating the product, the community can choose between one track or another from alternative paths for the future reconstruction of the desert, and gather around it, or put another alternative in the light of its contribution in the development of the scenarios of Egypt the future. Through interaction with this information, two results of great importance are achieved. First : the development of public opinion interested in the future of Egypt, and raise level of public awareness of the issue and challenges that lie ahead, and to promote dialogues concerning them. Second: to develop a new system in the management of the affairs of society and the state in which the decision-making process depends on solid foundations of a comprehensive and complex knowledge of the reality and an interactive multi-disciplinary perception to the future3. As the state orientation goes to the re-planning of the Egyptian village and pointing the borders of the residential area, the orientation of development axes and the desert back became a future reality that can not be ignored but must be confronted and arm the next generation and future generations to understand and bear their responsibilities.

6 Development and Egypt desert society

From where will the desert population come? What is the form of the pattern of architecture and construction of housing, schools, hospitals, streets, roads and squares? It's supposed that the population will be from all parts of Egypt; from Alexandria to Aswan with their different characteristics of a youth looking to prove themselves and so to be melted in one crucible to be the population of the Developmental Corridor, or Toshka. It is presumed that today's generation will be followed by generations of children and grandchildren who are the target to provide the Developmental Corridor with Toshka citizens and belongers.

As a start, the transfer of patterns and styles that were applied for long time in the valley to the desert would be undoubtedly a historic mistake. We should not be hasty to imagine solutions to the quality of the architecture of the future (the product) as the issue is not easy or simple. What should we do? The right solution is the scientific techniques and capabilities to help solving the problem of determining the architecture and planning appropriate to the nature of the desert4. The architectural competitions, architectural education and the implementation of other experiences are all mechanisms that allow the creation of multiple and different scenarios that vary in how they fit with the private sector participation, the goals of the state, the target time and place and the quality of the settlers. It is necessary to stress once again on the need of studying similar experiences in the world and the diversity of the studies and development of ideas in accordance with modern technologies. Also, it is important to study local materials of the Egyptian desert and the possibilities of their use in the construction and the construction systems appropriate to the desert in terms of temperature and ventilation and then study urban planning to be compatible with the desert environment. Moreover, there is a need to create an integrated society

4 - Abada, G. & El Khorazaty, T.: Toshka: A Disapointing Competition for All, In Medina Issue Ten, Architecture, Interiors & Fine Arts. British Virgin Islands, (November - December 1999): pp 50 - 57.

x - Hour, I: The Arabian Family, Researches on Family and Children, Alsharka, UAE, Vol.1, 1994, p11.

that has factors of culture, entertainment, media, education, investment, crafts, transportation and services required.

This may require time and the creation of a culture and a generation capable of understanding that this issue is serious and if it is available to us today to ask ourselves and to choose, tomorrow will be a matter of compulsion. But, in terms of philosophy of development of the desert it is a must to rely on the philosophy of scarcity that governs life in the desert as a basis and entrance to development. It requires changing some of the behaviours and habits to the extent of acquiring new behaviours and habits fitting in the new environment, and modern thoughts and tools that are capable of dealing with their positions taking into account social pluralism in the formation of the desert society.

7 The Desert: Raising and Self-Building:

"*Build your son and don't build for him*"

"*Raise your children for a time different from yours* (Omar Bin Al Khattab)"

"*Plato was asked: When do we start raising the child? He replied: before he was born hundred years ago. Abdullah: How can it be? He said: We must educate parents before him, the four grandparents.*5"

Children constitute about 40% of the total population of Egypt; they are stakeholders in the future of the country and today's children. Tomorrow Man is a citizen of Egypt, the desert, which he must understand how to think of the child? How to generate belonging to a certain family, tribe, certain city, certain province, specific homeland, one nation, creed, religion, culture and age. The study of the mentality of the Egyptian child and psychotropic leading to his understanding of the national identity, and belonging to certain culture, ideology, nation and religion, is the basis of the future vision for the reconstruction of the desert[6]. The importance of Egypt is attributed to experiencing a number of successive civilizations, and considering all that is foreign to the community as being modern, duely, the child grows distorted "realizes" and "believes" and finally "iminitates" others. The child is differently influenced by figures as father, adults and characters (Disney characters, for instance) fictional behaviour children follow as a model. Hence, the importance of examining[7] whose child-rearing and control of his surroundings, and inventing characters and imaginary environment that's self-made integrating with the contemporary reality, this could be the role of education through analysis and doing several researches to study the nature of the Egyptian child's mentality and his concept of the meaning of the word "national identity".

Think of the many studies on various themes like how to manufacture the future of the child in the desert? What future we can contribute to achieve, can it be for the architect to have a vision and an ideology and a means to translate researches and studies and conceptual thinking into applicable reality? And what is the extent of interest that study can reflect on the Egyptian community. Yet an examination of some of the various methods for the manufacture of the future followed by other states, and their ability to invade our society intellectually and culturally that an idea simple in content and deep in meaning can be grasped by a citizen who

---

6 -Lotman, Y, M.: Universe if the Mind. A Semiotic Theory of Culture, London, New York: Tauris, 1990.

7 -Patton, M.: Qualitative Evaluation and Research Method, Sage Publication Inc, 1990.

competes to live in the Desert without the desert being exile or punishment. The proposed simple suggestion can be a mean with a practical application represented in the creation of an imaginary integrated and studied environment (for the game), with goals having clear influence on the future of the Egyptian community through making the child "Tomorrow Man" experience the " reconstruction of the desert" with all the details of life; hopeful life drawn by its intellectuals and architects, bred in fantasy and imagination that qualify him with ability to face the reality creating the future of Egypt and the reconstruction of the desert. This game is a nucleus to confirm identity and establish the concepts for Egypt from Aswan to Alexandria and from Al Arish to Salloum. The game is a field and an opportunity to realize the dreams of the present generation towards the future generation.

8 Architectural Education and Architect's Responsibility:

Architectural education in most current educational institutes (in Egypt), is limited and inappropriate and should be developed towards the house, school and hospital, planning and ways for future Egypt. The suffering or architectural alienation we're going through today is the heritage of previous generations strove and struggled, hitting and missed.

It is a responsibility and battle to examine what children and grandchildren can inherit and self role present generation in this case. We can not ignore at the same time, the findings of the world including civilization and culture, innovations and thoughts. In this problem, we should have free choice at least as well as the existence of one or more alternatives for all of what we are trying to achieve urbanely and architecturally. Despite philanthropy and the permanent search and the efforts of the State in Egypt and what its cases involve projects, including studies and ideas, it is still possible to provide ideas that integrate with the efforts and function with all the organs of the state and all heads of families to provide protection for the people of this nation. And because the desert reconstruction will need new systems and theories that understand the pace of change and technicality through knowing the role and its relations with globalization either positive or negative, it is necessary to review some of the ideas concerned with the system as the construction of Egypt the future is a product and process steps.

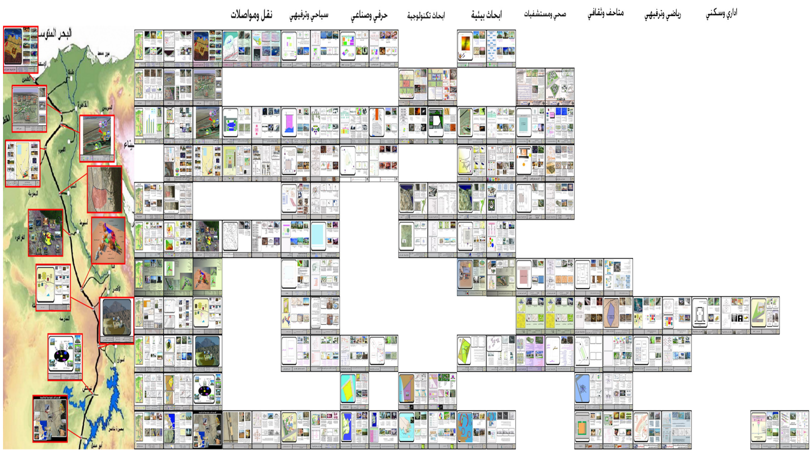
Some Egyptian Architects8 conducted some studies in which they developed theories looking for a link between the architect and modern vocabulary regarding techniques, relationships, innovations, inventions and accumulated ideas that depend on the understanding of the past and predict the future. Always modern theories are corresponded with a kind of controversy and reactions that vary between pros and cons. These theories have an important impact on the students, the implementation of such ideas on the British University in Egypt (the proposed

---

8 - Lecture by Prof. Dr. Medhat Dorra Professor and Head of Architecture at Cairo University in the opening of the Fifth Conference of Architecture Cairo University in February 21, 2006, entitled: “Architecture for Pilot Thinking, Speed and New Sim Thinking in the Architectural Studio”.

centre for sustainability and futuristic studies) and Mansoura University9. They try to contribute to the work and thought, and thus the orientation. The presence of personal attempts in the field of architectural education in the Arab world to discuss the reconstruction of the desert, relationships of heritage and modernity in forming the future needs to be studied and displayed.

The proposed theories adopt controversial idea that the future is an incomplete process that depends on fate and other measured things and therefore the scenario could change according to the interaction between the variables. The interplay of heritage and modernity with different degrees plays a role in future industry.



Graduation projects and 12 developmental axis (scenario 2005-2006)

9 - The first author of this paper surprised the graduation project at Mansoura University (from 2005-2008), which targeted the proposal of developmental corridor suggested by Farouk El-Baz. And was examined through the 12 developmental axes and about 90 architectural projects to be one of the scenarios provided by the young generation in which the goal of architectural education interacts with the responsibility of this generation towards the future generations.

The axis of Toshka one of the Developmental axis in the desert and the proposed projects

Cairo axis, one of the developmental axes in the

9 The desert and the proposed projects

Heritage is what is automatically gained depending on the genes (qualities vertically inherited from one generation to another over the generations and civilizations). In the study of heritage and architecture there are things for granted that can not be escaped and can not be known if they belong to the Greek or Renaissance civilization. There are things that can be selected from traditions because it indicates specific architecture and distinct civilization and can be replaced by another meaning or different expression. As for modernity, it depends on the characteristics that circulated by members of one generation and produced in a creative way the meme-tics. The development of the fetus (meme-tic) may be affected by multiple inputs, including cultural, political, technical, or other factors, of different rates from one region to another and for different goals and according to the genetics credit and its impact. This is why the vision of the future process is incomplete.

In the presented theories and views, there is an invitation to re-visit heritage, and to re-read inputs and modernity and to use new tools that would allow us through wearing new spectacles to have our own reaction by the relationship between heritage and modernity to form the future in a time when speed and the growing change in the requirements and techniques drive us to think about the potential in dealing with both the self, the time and the place to create of a new map for the future and to accept that the future of Egypt desert has more than one scenario. The actual reality might be something different from what has been conceived.

10 The pilot thinking in architecture and desert development

We must replace the culture of manoeuvre with the culture of confrontation. The culture assumes that the corridor development project or the project of settling in the desert is the common destiny of the nation, which requires confrontation thinking about the future. It is the culture of labourer and not the slogans and to start step by step in a clear and clear direction with a kind of patience, patience of work instead of dependency or despair.

In addition to that, the university education is a burden when not qualifying the graduates to meet the challenges of their future and the future of their homeland. Therefore, it was necessary, dealing with these theories seriously, and applying in the graduation project the concept of design studio and accept a theory that allows thoughts parallelism at the same time, a design studio is no longer one technical, but it has numerous visions of studios. There are different kinds of studios that discuss the following dialogues:

What is the status of heritage with the imaginary environment and the modern techniques that allows a return to the past and make scenarios with technology which means adding variables to what was presumed that it is unchangeable.

An attempt to link various theories and studies to reach a new reality (future incomplete) and at the same time to achieve the speed of pioneer thinking.

Fifth dimension in the desert: It goes beyond time and place and release the creativity potential of the human (activation of: historical values. Recalling: human understanding. Presenting: the time, the place, and the self)

What is the impact of genes in the growth of thinking and how long it takes?

Forming studio:

Traditional studio (pen and model)

Media studio (programming to access a new reality)

Cinematic studio (film production)

Aphoristic studio (Summery)

It is the logic of the maze (the logic of illogic), that comes from experience and not understanding and the future can not be left to self pushing

The theory of how to create new thinking by living in the scenario.

Pilot thinking is a method that permits a bridge to link between heritage and modernity for seeing the future and development of the desert and this should be done soon.

An example of the speed and created heritage in the age of globalization, what happens in Dubai, which is a reconstruction that changes not only Dubai, but the whole world architecture.

How to link between two times that differ in texture and method of presentation. How to link two historical ages and to relate constants, variables and excesses (architecture between logic and illogic).

In the end, how to form Egypt future and the future of the Arab world through heritage credit, modern technique and understanding of modernity.

11 Conclusion and Recommendations

The research paper sought through scientific methodology addressing the research hypotheses, to discuss the reconstruction of the desert and the role of the architectural education in forming the cadres and the coming generations of the future. Here a question arises, which futures are we making and how? Could we have a vision and a means to translate research papers, studies and conceptual thinking into applied reality? What is the extent of the benefit which would be reflected on the community of the Arab nation as a result of these conferences, studies and research papers that derive their value from their ability to contribute to the analysis of our problems to reach the findings and recommendations ready be translated into mechanisms and future plans so as to contribute to the vision and the industry of the future.

The research here is primarily concerned with the desert, investment opportunities, reconstruction work and the role of architectural education as influential or being influenced by other factors. In the research a problem was reviewed: to invade or to settle in the desert and the environmental dimension of the desert and the importance of strategic environmental assessment studies, as well as the future of Egypt and the various proposals such as the corridor of reconstruction and document of the twenty-first century, projects of desert back villages and towns, and what could be the form of reconstruction product and desert society. This form stems from the aimed steps and the issue of raising and self-building. The concept of “Build your son and don't build for him". Hence, comes the debate about the issue of architectural education and the responsibility of the architect and finally the pioneer thinking in architecture and desert reconstruction.

Views and theories that can keep pace with development, modernity and speed were also discussed. They could play a role with understanding and awareness in assuring the role of applying this through distinct architects who think and apply these theories in graduation projects, which allow positive influence instead of depending on receptive to turn the matter to a kind of contribution. With time, lost leadership can be retained by experimentation and not reclusion and vague slogans. Findings and recommendations of the research paper can be summarized in the following:

- The historic role of construction between heritage and globalization has been and still influential in the construction and settling in the desert.

- Environmental dimension and Strategic environmental assessment is a necessity to ensure the developmental sustainability.
- Penetrating the future can be achieved through self-understanding, education and focusing on the aimed steps and not to rush the product as practical aimed steps though they may take time but they shorten times instead of the trial and error method of the unstudied product.
- Architectural education is a means of self building. Settling in the desert is not optional and we must invest the opportunity because it allows for realistic investment opportunities stemmed from the needs of society.
- What the architect needs today is more than a mere understanding of construction skills, it is to understand the development of the age and renewable techniques and try to create a space for understanding the mechanism of knowledge and techniques and factors of change. It is a must to gain a profound understanding of the heritage which he adds to or modifies through his works. Architectural education and training are the possible basis for a better future.
- There is a need to spread awareness and the consolidation of the size of the architectural community participation, in particular, and the international community in general in the reconstruction of the desert.

12 References

URBA project: developing new urban housing concepts in the Helsinki metropolitan area

Dr Sari Puustinen, Jonna Kangasoja

Helsinki University of Technology, Finland

The paper describes a research and development project entitled URBA (2007-2010) that was initiated to foster the vitality of urban dwelling in the Helsinki Metropolitan Area, which faces the threatening prospect of urban sprawl. Problems in the area, such as soaring prices and lack of feasible and attractive housing alternatives, are the result of a narrow and inflexible housing market. Moreover, the housing sector suffers from a lack of cooperation. In this situation, the overall aim of establishing a sustainable urban structure and providing feasible and attractive housing needs to be conceptualised in a way that takes into account the contradictory needs of actors in the area. URBA is a multi-disciplinary research project that brings together a wide range of stakeholders and actors of the housing sector. The first phase of the project has produced an initial selection of promising urban housing concepts, which serve as the basis for the development phase. The development phase is structured in the form of a collective learning and invention process that involves a wide group of participants from the housing sector.

Keywords: knowledge management, participation tools, stakeholder perspectives, sustainable housing, urban structures

The paper describes a research and development project entitled URBA (2007–2010) that was initiated to foster the vitality of urban dwelling in the Helsinki Metropolitan Area, which faces the threatening prospect of urban sprawl. Problems in the area, such as soaring prices and lack of feasible and attractive housing alternatives, are the result of a narrow and inflexible housing market. Moreover, the housing sector suffers from a lack of cooperation. In this situation, the overall aim of establishing a sustainable urban structure and providing feasible and attractive housing needs to be conceptualised in a way that takes into account the contradictory needs of actors in the area. URBA is a multi-disciplinary research project that brings together a wide range of stakeholders and actors of the housing sector. The first phase of the project has produced an initial selection of promising urban housing concepts, which serve as the basis for the development phase. The development phase is structured in the form of a collective learning and invention process that involves a wide group of participants from the housing sector.

1. A Narrow and Inflexible Housing Market: An Obstacle to Sustainable Development

The Helsinki Metropolitan Area suffers from severe problems in housing and urban planning. International surveys show that the area is relatively decentralised (e.g. OECD 2003). As a result of soaring prices and one-sided supply in the housing market, the Helsinki Metropolitan Area is suffering from urban sprawl. Families in particular are moving from the centre to the suburbs, where they are able to afford a larger dwelling and a garden of their own. This development is very much dependent on private motoring, it exacerbates climate change and is against the principle of sustainable development.

Helsinki Metropolitan Area is one of the fastest growing metropolitan areas in Europe. It is Finland's capital for business, education, research, culture and government. Some 70% of foreign companies operating in Finland have settled in the area. The influx of inhabitants comes both from Finland and abroad. The percentage of foreign nationals in the population in the area has grown rapidly in recent years, and the growth is expected to continue (Vuori 2007).

Picture 1. Helsinki Metropolitan are consists of four municipalities with city status: Helsinki, Vantaa, Espoo and Kauniainen. The area covers 745 square kilometers, and its total population is about one million (Helsinki Metropolitan Area Council, 2007).

The housing market in the Helsinki area is narrow and one-sided in more ways than one. The market is lacking in flexibility, which has a negative effect on the competitiveness of the region. There is a constant shortage of reasonably priced dwellings for a number of target groups. The ideal of home-ownership predominates, and the supply of rental dwellings is insufficient. In times of fluctuating economic conditions, the acquisition of a dwelling for a short period of time, if only for a couple of years, is a risky proposition. For example, an expert moving temporarily to the area with his/her family from abroad is in trouble. The housing market operates almost exclusively in the Finnish language. There is a marked shortage of dwellings for rent and of services for moving and adapting to new conditions.

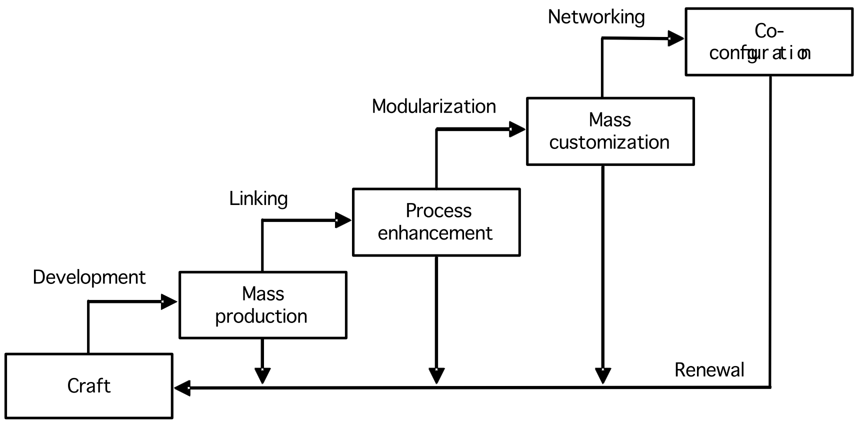
Urban living and the production of new dwellings are both in need of greater flexibility, because the population in the capital region is more heterogeneous than average. Differences in income and social status are greater than elsewhere. The percentage of foreign nationals in the population is considerably higher than elsewhere. The structure of professions is also different than in Finland on average. There are proportionally more people than average in supervisory or leading positions, specialists, IT professionals and professionals in the natural sciences and in artistic professions, as well as office and customer service personnel. The Helsinki region is suffering from workforce shortage now and will do so in the near future. There is a shortage of nurses, social and health services personnel, bus drivers and cleaners. These are typical groups whose settlement in the capital area is hampered by the high prices in the housing market. There is relatively little employer-provided housing, even though this would help people move into the capital region and also help them settle down. Moreover, employer-provided housing would also make employees more committed to their employer.

Housing production in Finland remains predominantly in the hands of Finnish developers, and over the decades practices have become entrenched. One factor that explains the nature of housing policy and urban planning in Finland is that it was first after World War II that urbanisation got under way here and prosperity increased, and residential suburban areas were developed by public-private partnerships. Another important factor was Finnish welfare policy which put an emphasis on equitable housing, yet at the same time led to a lack of diversity in industrial housing production.

This lack of diversity in current housing production is one of the main problems in the housing market today. The majority of new housing consists of mass-produced multi-storey residential buildings, and from the consumer's viewpoint alternatives are hard to find in the market. In practice, the choice of dwelling is dictated by location and price, which in turn largely depends on the location. In terms of their floor plan, fittings and materials, new dwellings are very uniform. Even in expensive and trendy properties that are carefully branded in view of a particular customer group, the dwellings themselves are ordinary. In mass-customised housing areas, the buyer's possibilities to have a say in the dwelling are generally limited to the choice of finishing materials, cabinet doors and domestic appliances that alternatives for which have all been decided beforehand. In the rental market, the occupant's options are even slimmer, even though some experiments in participatory planning have been carried out. The design of residential buildings is typically conservative. There is a general belief that occupants want things that are safe and familiar. There is fear that unusual solutions might scare away the customers and obstruct the resale market later on. It is safer for the occupant to be flexible than for an expensive dwelling. (Rask & Timonen & Väliniemi 2008.)

2. From mass production towards co-configuration in housing production

Industrial housing production in Finland can be examined in terms of the historical stages in the development of work and production as described by Bart Victor and Andrew Boynton (1998), in particular its second stage, mass production.



Picture 2. The historical stages in the development of work and production (Victor & Boynton 1998).

Victor and Boynton have identified five stages in which the operative principles, know-how and production management are all different. The five stages of production are craft work, mass production, process enhancement, mass customisation, and co-configuration. The last stage is based on continuous collaboration and reconfiguration of the product between the producer network and the user. Although the five stages of production are the result of historical development, the first four of all co-exist today. The stages are not mutually exclusive, but complementary. Historically, progress from one stage to the next has always required technical and/or technological innovations and possibilities for new core inputs. Every technological revolution (water power, motorisation, electricity, information technology) have led to new opportunities for organising work and production. For example, the revolution in information technology is currently making a crucial difference in the division of labour, but also increasing the need for interaction and cooperation. However, we are still just taking the first steps towards the fifth stage, co-configuration. (Victor & Boynton 1998, Freeman & Louçã 2001.)

Housing production in Finland consists typically of industrial mass production based on a concrete element system. The most advanced form of production employed to date in multi-storey residential buildings is mass customisation. It has nevertheless been used relatively little and is more common in the production of detached houses.

The Finnish housing sector, which in this context covers urban planning, housing policy, housing production and housing market, has many actors. The problem is that no single actor is responsible for the overall workings of the system, nor have any general targets been set for it anywhere. Cooperation between different actors is infrequent and incidental. The operating conditions of the sector are determined by the State through legislation and norms. Municipalities are responsible for land use policy, land use planning and building control. Banks and investors provide funding, developers and building companies construct, market and sell their products. The system is a complex network of codes and nodes of intersecting interests and actors. The key factors are economic trends, interest rates and the prevalent interests in housing policy.

All actors in the sector have their own ways of operating, their own aims and earning logic. The aims as such are good and useful, at least from each actor's own perspective. However, sometimes the multitude of implemented aims leads to undesirable side effects for the occupants. For example, an environment that meets every single norm regarding safety in traffic can be dull and unaesthetic. Similarly, complying with all the norms and standards of housing design does guarantee a healthy and safe environment, but can push up the price of dwellings. New dwellings fitted with all possible conveniences may give the occupants a sense of a high standard of living, but will above all line the pockets of the developer who sells it.

Risk management is a key factor in the operation of the various actors in the housing sector. All actors have their own ways of managing and outsourcing the risks involved in their operation. One typical feature of the housing sector is that actors demand that other actors take risks, such as implementing experiments in housing policy, yet they are not willing themselves to take risks or to change their own modes of operation. The results can be seen in the inflexibility and dull character of the housing market, where supply dominates demand.

This situation may be changing, however. The global economy also affects the Finnish housing market. The economic downturn that began in 2008 was reflected quite rapidly in housing production in the Helsinki Metropolitan Area. There are currently thousands of expensive, privately funded dwellings (free from price regulation) unsold in the area. Non-subsidised housing production has come to an almost complete standstill. The construction sector is facing a deep recession and mass unemployment. The Finnish housing industry has already turned to the State and the municipal sector, asking for measures to alleviate the situation. Cities in the Helsinki Metropolitan Area are in fact increasing the production of subsidised rental dwellings. It will be interesting to see whether the housing industry will change its operating approach by, for example, increasing R&D or trying out new housing concepts.

3. Research and Development Project URBA seeks solutions for sustainable housing and urban structure

Decision makers and authorities on all levels, built environment professionals and developers in the Helsinki Metropolitan Area have recently come out with statements that the problems of housing and urban structure must be solved collaboratively. One serious issue bringing actors together is climate change. For example, the Climate Strategy for the Helsinki Metropolitan Area 2030 (drawn up by the Helsinki Metropolitan Area Council and the four cities of the area) sets the target that greenhouse gas emissions must be reduced by more than one third from current levels by the year 2030. This can only be achieved with a denser urban structure and traffic based on public transport, walking and cycling. Moreover, the design, development and use of buildings should be guided by whole life-cycle costs, energy efficiency, versatility and degree of use.

The Centre for Urban and Regional Research initiated a three-year research and development project, **The Future Concepts of Urban Housing – URBA** that has the subheading **Diversification and Attractiveness of the Housing Stock in the Helsinki Metropolitan Area** together with a large stakeholder group. The project was launched in autumn 2007 and will continue until April 2010. URBA is a part of the housing-related *Centre of Expertise* programme, as well as the *Innovative City* development programme of the City of Helsinki (see www.urba.tkk.fi).

3.1 The overall aims of the URBA project

URBA represents a new approach to knowledge production. The strengths of the project are reflexivity, interdisciplinarity, innovative research methods and the large number of collaborative actors and financers participating in it. The project also involves international cooperation with American as well as European universities, and its interdisciplinary group of researchers includes experts from the Centre for Urban and Regional Studies (YTK) at the Helsinki University of Technology, the National Consumer Research Centre of Finland, the Technical Research Centre of Finland, and from City of Helsinki Urban Facts. Principal funding for the project comes from the Finnish Funding Agency for Technology and Innovation (TEKES), but additional funding is provided by the cities in the Helsinki Metropolitan Area, the Finnish Ministry of the Environment, the Helsinki Metropolitan Area Council, and several construction companies and developers. The project is headed by Professor Raine Mäntysalo, Director of the Centre for Urban and Regional Studies. The Principal Investigator is Professor (emerita) Hilkka Lehtonen.

The URBA research and development project aims to answer the following questions:

- How can urban living be made more attractive in a way that does not lead to excessive urban sprawl?
- Which resident groups are in a key position regarding the urbanisation and development of the Helsinki metropolitan area?
- What kind of new urban housing concepts can be developed on the basis of international examples and subsequently applied to new construction?
- How are new housing concepts received by the key resident groups in the Helsinki Metropolitan Area, and how do they relate to urbanisation in Finland?
- How can the new concepts be utilised in diversifying housing and promoting sustainable development?

The central goal of the URBA project is to bring together actors in the housing sector in the Helsinki Metropolitan Area, and to initiate a collective brainstorming process to find new solutions to the conflicting needs of the various stakeholder groups. This process takes place in two stages: 1) finding promising new urban housing concepts through international comparison, and 2) establishing a structured development process (seminars, working groups) for developing these further into viable new operating concepts and business models that are appropriate for the particular local context.

A sub-project of URBA is looking to draw up a set of criteria for evaluating the attractiveness of any given living environment and to create a tool for analysing it. The tool is being developed by City of Helsinki Urban Facts and will be tested in the Helsinki Metropolitan Area.
The URBA project also aims to intensify connections between Finnish and international research in the sphere of housing and housing development with a view to furthering cooperation in the future. Its final results will be presented in the form of a concise publication and an illustrated concept database with web-based maps.

3.2 The first phase of the project produces promising housing concepts

In the first phase of the project (2007–2008), the task was to identify and pre-evaluate interesting international concepts for urban housing and to develop preliminary descriptions of them. A number of international housing concepts and models from Denmark, the Netherlands, Germany, Switzerland, UK and USA were found. In November 2008 the project published a book that gathered together the results and experiences from the first phase. The book *Another Way to Dwell? Looking for new concepts for urban housing* (Norvasuo (ed.), 2008) includes descriptions of the international concepts as well as theoretical articles on related themes. It also discusses user experiences in the development of international housing concepts, their developers, and the role of consumers in the related processes.

The applicability of the new concepts in Finland was first tested in October–November 2008 using the methods of public participation. The idea was to integrate public participation in the innovation process as early as possible. The new housing concepts were evaluated by consumers in focus group discussions organised by the National Consumer Research Centre (See Heiskanen et al. 2008). The final analysis of the data gathered in these discussions is currently still under way.

The focus groups consist of 4–12 people brought together to participate in a discussion on some area of interest. The discussions are conducted by trained moderators, and the course of the discussions is documented. Focus groups produce research data by generating social interaction. This is done by assembling a group of participants to discuss a specific topic – in this case the new housing concepts – and observing how the ensuing discussion evolves. (Heiskanen 2008, see also Boddy, 2005.) The underlying assumption is that meaning will be created in the course of the interaction (e.g., Wilkinson, 2001). Organised and focused group discussions provide a context for participants to articulate their experiences and to elaborate on them in a collective sense-making process (Heiskanen et al. 2008). Participants are encouraged to define the concepts and framings themselves. Since the discussion is conducted in a group, participants have an opportunity to learn from each others' comments. Focus group discussions also support collective sense-making processes; when dealing with complex topics, participants can pool their prior knowledge and experience. Thus, the viewpoints gained are more carefully articulated than, for example, immediate responses to survey questionnaires (Heiskanen, 2005; Timonen, 2002).

Focus groups highlight lay experience rather than ignorance, and can thus make a positive contribution to policy making (Cunningham-Burely & Kerr & Pavis, 2001). Focus groups are a frequently used method in marketing research, but today they are also used in serious research in the social sciences. In the past few decades, they have established their role in sociology and communications research. More recently, they have also become increasingly popular in applied fields such as urban and community studies, development studies, and educational research (e.g. Nancarrow & Vir & Barker, 2005; Barbour & Kitzinger, 2001; Gibbs, 1997). They are also used increasingly for practical ends such as evaluation, community improvement and empowerment. (Heiskanen et al. 2008).

In addition to consumers, participants in the focus group discussions also included some housing and planning experts. Preliminary concepts were presented by researchers from the URBA project, who also made observations regarding the discussions. The discussions produced valuable research data (the final analysis remains to be completed by the National Consumer Research Centre). One thing that came up in the discussions was cultural differences between international concepts and Finnish traditions regarding housing and dwelling. For example, the researchers introduced the concept of *James-serviced apartments*, which originally comes from Switzerland. Some consumers expressed the opinion that such services linked to the dwelling would not have any demand in Finland. In addition to this, many legislative, social and financial obstacles to the implementation of the preliminary concepts surfaced in the discussions. This was just the kind of information the researchers wanted to gather.

It was observed by the researchers, however, that focus group discussions would be more suitable for testing finished products and ideas rather than for developing new concepts. The task of introducing consumers to undeveloped, unfinished and incommensurable concepts was considered too difficult and demanding. The content of some of the concepts was unclear even to the researchers themselves. They were more like ideas or notions than concepts. In the case of some concepts, the consumers were embarrassed to discuss them, because they did not understand what the concept was, or what it was for. It was also noticed that there was too little time and too many concepts; there was barely enough time for proper discussion. Furthermore, even if the participating consumers felt that the discussions were very interesting and they were enthusiastic about the topic, we may ask if the focus groups were participatory and empowering (see also Heiskanen et. al. 2008; Chiu, 2003; Waterton & Wynne, 2001; Wilkinson, 2001).

On the basis of these observations and the preliminary results, the URBA research group selected five concepts for further development. These were:

- **Settle-down flat** (Modest or moderately priced and equipped, easy- to- get rental apartments for transitory life situations. Target groups: newcomers, immigrants, students, low-wage employees, temporary workers, divorcees etc.)

- **James – serviced apartments** (Centrally situated, mostly rental apartments combined with services, such as cleaning, laundry, shopping, walk the dog, etc. to ease everyday life. Target groups: modern city people, 'yuppies', singles, ITC workers, people who travel a lot, etc.)

- **Group building and/or self-help housing** (Building a house or a group of houses by a voluntary, non-profit group of future occupants, assisted by professionals. The aim is a building that serves individual and/or group needs better than an ordinary building. Target group: active inhabitants who want to participate more than average in decisions affecting their living environment, and are committed to participate in a demanding planning/building process.)

- **Town house** (An old concept that is common in many countries except for Finland. Mostly private houses with a front door facing the street and a small (backyard) garden. Target groups: families and those who want a private garden, but prefer urban living.)

- **Flexible housing – user-initiated flexibility** (The concept focuses on the flexible organisation of space properly scaled for the site. The dwelling can accommodate changes over time concerning styles of habitation and use of space. This represents a change from function-based design thinking towards organisation-based thinking.)

These concepts are incommensurable as regards housing design, construction, and dwelling. They are not finished, fixed solutions to the housing problem, but examples of what can be achieved if we alter the prevailing system of urban planning and housing production in Finland. These preliminary concepts are answers to broader development needs, such as densifying the urban structure, developing rental housing, combining housing with services, increasing the possibility of inhabitants' self-determination, increasing user-initiated flexibility of buildings, developing the management and control of the building process, and developing the sustainability of housing.

4. URBA 2009: Developing new modes of operation and business models through a research-based intervention process

The focus of the URBA research and development project shifted more explicitly towards development in the beginning of 2009, when the intervention phase of the project began. The term 'intervention' is used here in the sense of a deliberate attempt, in this case by researchers, to effect a change in the reality being studied. This type of research is often termed 'action research', but because action research has its own established tradition, with particular theoretical and methodological tools and concepts (see e.g. Lewin, K. 1946, Carr & Kemmis 1986, Reason & Rowan 1981, Stringer 1999), we want to distinguish our approach from action research proper. When describing the overall organisation of the process, we shall therefore discuss in somewhat greater detail the theoretical foundations underlying the design of our intervention process.

4.1. The organisation of the development process in the URBA project

After the first phase of the URBA project was completed and the book presenting the initial findings of the international study of promising urban housing concepts (Norvasuo 2008) was launched at the end of 2008, key actors of the housing sector in the Helsinki Metropolitan Area were invited to an all-day working seminar held in the beginning of February. Out of the 80 invitees 60 participated. The participants represented all major stakeholders and actors, such as legislators from the Ministry of the Environment, key officials and planners from the cities of Helsinki, Espoo and Vantaa, and representatives from major construction companies, real-estate developers and investors.

The seminar was organised with the principles of the Change Laboratory method in mind. (The theoretical ideas behind the method are explained below.) In the seminar, participants were offered two types of 'cognitive stimuli' in order to launch a collective learning process. The first type of 'stimuli' was comprised of views on the challenges of housing production in the Helsinki Metropolitan Area. These were provided in the form of a statistical overview of the demographic development of the region, presented by the leading statistician Pekka Vuori from the City of Helsinki Urban Facts.

Pekka Vuori's presentation emphasised the two main demographic challenges that need to be addressed in urban planning and housing production in the region: ageing population and the very significant increase in the number of migrants in the area. Next, formulations of the problem and challenges were solicited from the seminar participants. These formulations included the challenges and imperatives related to climate change and sustainability discussed in the beginning of this paper. However, many institutional shortcomings were also identified in the incentive structure of the housing sector, as well as a lack of suitable actors in the field (e.g. advice bureau for self-help builders) and tools, such as flexible financial instruments. The problems of the current practice and how the potential new is emerging from within it were brought to life by architect Karin Krokfors with a concrete case of a pilot construction project 'Vanhankaupungin Kellokas', in which several of the promising new concepts are being explored in one and the same project including group building, townhouse and flexible housing.

Jaakko Virkkunen gave a keynote lecture in which he linked the widespread interest in concepts, reflected also in URBA's desire to find new concepts for urban housing, to the idea of historical change in the modes of production and work and the resulting dynamical nature of business concepts.

Virkkunen has noted that the term 'concept' has different meanings in different situations and contexts. It is often used to describe a half-finished output, the first idea or a sketch. However, just like any invention, a concept matures from its first, sketchy idea into a finished product or practice through many phases of concretisation and elaboration. When an original idea starts to acquire a concrete form, an increasing number of practical demands are brought to bear on it, and the idea is brought into completion and formed by those demands. (Virkkunen 2002).

In his lecture, Virkkunen made use of the model, developed by Bart Victor and Andrew Boynton, of historical types of work associated with each era of key technological innovation, and also theories of the long waves of economic development.

Virkkunen writes:

> According to Victor and Boynton's model, an activity can be developed within the prevailing concept: craft as craft, mass production as mass production etc., or the concept of the activity can be transformed: from craft to mass production, from mass production to process enhancement etc. The latter can be seen as processes of collective expansive learning (Engeström, 1987), in which a new concept is created and implemented to overcome a developmental dead end and an aggravating inner contradiction within the prevailing one. Collective expansive learning processes are typically complex long-term processes in which the actors continuously encounter new contradictions within the activity that they have to overcome expansively. (Virkkunen 2007, p. 160)

These theoretical ideas, together with the presentation of the promising urban housing concepts, were the second type of 'cognitive stimuli' presented at the working seminar. Consisting of theoretical models and conceptualisations, they were intended as an aid for the participants to being re-conceptualising and reframing the aforementioned initial problems and challenges, and thus to enable expansive learning (Engeström 1987).

Expansive learning is a step-wise process of collective 'learning actions' that lead to a qualitatively new type of activity in which the initial contradiction has been overcome by re-mediating the system. Learning actions are different in the different phases of the expansive cycle, and they can be described typologically as follows: questioning the present practice; analysing the history which has lead to the current practice; constructing hypotheses about the underlying developmental contradictions; modelling new solutions; and experimenting and evaluating the experiments.

4.2. Working groups

Thematic working groups were established on the basis of the points of interest expressed by participants in the first intervention seminar. Participants were given an initial list of five groups, based on the selection of international examples made by the researchers (presented in section 2). The participants themselves suggested several additional working groups, and after merging some of the suggested groups thematically, the following eight working groups were established:

- Town house (12 members)
- James – serviced apartments (9 members)
- Group building and/or self-help housing (13 members)
- Flexible housing – user-initiated flexibility (13 members)
- Settle-down flat (9 members)
- Development of multi-storey residential housing (14 members)
- Concepts for housing combining dwellings and commercial services and "downtown" dwelling (9 members)
- Developing forms of management and funding instruments (12 members)

These groups have also attracted the interest of others who did not participate in the first working seminar. As the list shows, approximately 80 people are involved in the URBA development process, even though some of them are members in more than one thematic group. In other words, the process has attracted major interest and acceptance among key actors in the housing sector in the Helsinki Metropolitan Area. Each of the groups will meet 1-3 times before the next joint all-day working seminar, which will take place in May 2009.

In order to enhance opportunities for collective invention and to strengthen distributed ownership and organisational and institutional anchoring, the thematic working groups are structured on the following principles: They self-organising and independent, that is, the ownership of the groups belongs jointly to the participants. All participants can bring in their own interests to see how they can be useful to the group. The URBA researchers serve as secretaries in the groups, and their notion of what the groups are for and about is just one legitimate interpretation among others. The groups are temporary and open-ended; they can outlive the URBA project and invite more participants along the way. The groups are 'flat', that is, structured in such a way that all participants are equal regardless of formal institutional position. Heads of organisations, lay persons and students all engage in the same dialogue.

4.3. The theoretical basis of the intervention process

The design of the intervention process in the URBA project is rooted in the Finnish methodology of developmental work research. The approach builds on the theoretical traditions of cultural historical psychology (L.S. Vygotsky, A.R. Luria, M. Cole) and activity theory (A.N. Leontjev, Y. Engeström).

Jaakko Virkkunen describes the approach as follows:

> Developmental Work Research (Engeström, 1987, 2000, 2005b) is an interventionist methodology that aims at prompting and supporting practitioners' agency in analyzing and transforming the system of their joint activity. Agency here means breaking away from the given frame of action and taking the initiative to transform it. According to Bandura (1989, p.1175-1177), agency depends on actors' beliefs about their capabilities of exercising control over what is going on. Belief in self-efficacy is not the developmental starting point, however, and external artifacts play a crucial role. As Vygotsky has shown, "The development and use of artificial stimuli play an auxiliary role that permits human beings to master their own behavior, at first by external means and later by more complex inner operations" (Vygotsky, 1978, p. 73). People develop and use external artifacts to reach a redefinition of the situation and to control their own actions. They do so, however, not as isolated individuals but as members of a community. A number of individuals can collaboratively develop and use a shared artifact to enable them to redefine their situation and to master their joint actions in transforming the context of their daily work. (Virkkunen 2006, p. 49.)

The theory of expansive learning was formulated by Engeström in his 1987 book *Learning by Expanding. An activity-theoretical approach to developmental research*. However, this interventionist methodology has already been evolving in the past three decades in the context of actual development projects of real-life organisations. Since the mid-1990s, this has taken place mainly in the context of a particular method called *Change Laboratory* (see e.g. Engeström, Y & al. 1996, Virkkunen 2006).

The Change Laboratory method is not being applied in the URBA project in any strict sense, however. Rather, we have been inspired by the theoretical ideas underlying the method, namely ideas as well as experiences on how to initiate and sustain a process of collective invention in the context of multi-organisational and cross-sectoral problem definition and solving.

References:

Ahonen, H.& Engeström, Y. & Virkkunen, J. (2000). Knowledge Management – The second generation: Creating competencies within and between work communities in the Competence Laboratory. In Y. Malhotra, (ed.) Knowledge Management and Virtual Organizations. London: Idea Group Publishing, 282-305.

Barbour, R. S., & Kitzinger, J. (Eds.). (2001). Developing focus group research: Politics, theory, and practice. London: Sage.

Boddy, C. (2005). A rose by any other name may smell as sweet but "group discussion" is not another name for a "focus group" nor should it be. Qualitative Market Research: An International Journal, 8(3), 248-255.

Carr, W. & Kemmis, S. 1986 Becoming critical: Education, knowledge, and action research. Philadelphia: Falmer.

Chiu, L. F. (2003). Transformational potential of focus group practice in participatory action research. *Action Research, 1*(2), 165-183.

Cunningham-Burely, S.& Kerr, A., & Pavis, S. (2001). Theorizing subjects and subject matter in focus group research. In R. S. Barbour & J. Kitzinger (Eds.), *Developing focus group research: Politics, theory, and practice* (pp. 186-199). London: Sage.

Engeström, Y.(1987). Learning by expanding: An activity-theoretical approach to developmental research. Available at http://lchc.ucsd.edu/MCA/Paper/Engetrom/expanding /toc.

Engeström, Y. (1992). Interactive expertise. Studies in distributed working intelligence. University of Helsinki, Department of Education. Research Bulletin 83.

Engeström, Y, (2008). From Teams to Knots. Activity-theoretical Studies of Collaboration and Learning at Work. Cambridge University Press, New York.

Engeström, Y.& Pasanen, A.& Toiviainen, H. & Haavisto, V. (2005). Expansive Learning as Collaborative Concept Formation at Work. In K. Yamazumi, Y. Engeström & H. Daniels (Eds.), New Learning Challenges: Going beyond the Industrial Age System of School and Work, Osaka: Kansai University Press, 47-77.

Engeström, Y. & Virkkunen, J. & Helle, M. & Pihlaja, J. & Poikela, R. (1996). The Change laboratory as a tool for transforming work. Lifelong Learning in Europe, 1(2), 10-17.

Freeman, C. & Louça, F. (2000). As Time Goes By. Oxford: Oxford University Press.

Gibbs, A. (1997). Focus groups. Social Research Update, 19. Retrieved from
http://www.soc.surrey.ac.uk/sru/SRU19.html

Grant, R. M. (1996). Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. Organization Science 7, 375–387.

Heiskanen, E. (2005). The performative nature of consumer research: Consumers' environmental awareness as an example. Journal of Consumer Policy, 28(2), 179-201.

Heiskanen, E. & Järvelä, K. & Pulliainen, A. & Saastamoinen, M. & Timonen, P. (2008). Qualitative Research and Consumer Policy: Focus Group Discussions as a Form of Consumer Participation. The Qualitative Report Volume 13 Number 2 June 2008 152-172. http://www.nova.edu/ssss/QR/QR13-2/heiskanen.pdf

Henderson, R. M. & Clark, K. B. (1990). Architectural innovation: Reconfiguration of existing product technologies and the failure of established firms. Administrative Science Quarterly 35, 9–30.

Lewin, K. (1946) Action Research and minority problems. Journal of Social Issues 2, 34-46.

Mäntysalo, R. & Puustinen, S. (2008). Towards the Co-Configuration of New Urban Housing Concepts. (In Finnish) Article in Norvasuo, M. (ed.)(2008): Let's find new concepts for urban housing (In Finnish). Publications of Centre for Urban and Regional Studies, B 95, Helsinki University of Technology, Espoo.

Kerosuo, H. & Engeström, Y. (2003). Boundary Crossing and Learning in Creation of New Work Practice. Journal of Workplace Learning. 15(7/8), 345-351.

Nancarrow, C.& Vir, J., & Barker, A. (2005). Ritzer´s McDonaldisation and applied qualitative marketing research. Qualitative Market Research: An International Journal, 8(3), 296-311.

OECD (2003). OECD Territorial Reviews. Helsinki, Finland. 235 s. OECD Publications, Paris.

Reason, P. & Powan, J. (Eds.) (1981). Human inquiry: A sourcebook of new paradigm research: New York: John Wiley

Rask M. & Timonen P. & Väliniemi J. (2008) Kuluttajamyytit asumisen mikroilmastossa. In: Lammi M. & Timonen P. (toim.). Koti - Tehtävistä uusiin ihanteisiin. Kuluttajatutkimuskeskus.

Star, S.L. & J.R. Griesemer (1989). Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39, Social Studies of Science, 19, ss. 387-420.

Stringer, E.T., (1999). Action Research, second edition. Thousand Oaks, CA: Sage publications

Timonen, P. (2002). Pyykillä: Arkinen järkeily ja ympäristövastuullisuus valinnoissa [Doing the laundry: Mundane reasoning and environmentally responsible choices]. Helsinki, Finland: National Consumer Research Centre.

Waterton, C., & Wynne, B. (2001). Can focus groups access community views? In R. S. Barbour & J. Kitzinger (Eds.), *Developing focus group research: Politics, theory, and practice* (pp. 127-143). London: Sage.

Victor, B. & Boynton, A. (1998). Invented here. Maximizing your organization's growth and profitability. A practical quide to transforming work. Boston Mass.: Harvard Business School Press.

Wilkinson, S. (2001). How useful are focus groups in feminist research? In R. S. Barbour & J. Kitzinger (Eds.), *Developing focus group research: Politics, theory, and practice* (pp. 64-78). London: Sage.

Virkkunen, J. (2002). Konseptien kehittäminen osaamisen johtamisen haasteena, in Virkkunen, J. (toim.): Osaamisen johtaminen muutoksessa. Ideoita ja kokemuksia toisen sukupolven knowledge managementin kehittelyyn. Työelämän kehittämisohjelma 20, Helsinki. Ss. 11-51. URL: http://www.mol.fi/mol/fi/99_pdf/fi/03_tutkimus_ja_kehittaminen/02_tykes/05_aineistopankki/julkaisut/jvirkkunen.pdf

Virkkunen, J. (2006). Dilemmas in building shared transformative agency. @ctivités, 3 (1), 44-66, http://www.activites.org/v3n1/virkkunen.pdf

Virkkunen, J. (2007). Collaborative development of a new concept for an activity. @ctivités, 4 (2), pp. 158-164, http://www.activites.org/v4n2/v4n2.pdf

Virkkunen, J. & Ahonen, H. (2004). Transforming Learning and Knowledge Creation on the Shop Floor. International Journal of Human Resources Development and Management, 4(1), 57–72.

Virkkunen, J. & Tenhunen, E. (2007). Eri alojen asiantuntijoiden työpanoksen yhdistävän toimintakonseptin kehittäminen – tapaus liikuntavammaisten ja neurologisesti sairaiden lasten erityisoppilaitos, Konsepti 4 (1), ss. 1-27.

Vuori, Pekka (2007). Population trends in Helsinki and Helsinki Metropolitan Area. www.hel.fi/wps/wcm/connect/4cadbd804a525986bf3cffc230444d78/Ulkomaalaistrendit2007.ppt?MOD=AJPERES

Woolcock, M. (1998). Social capital and economic development: toward a theoretical synthesis and policy framework. Theory and Society 27, 151–207.

London's energy system: assessing the quality of urban sustainability indicators using the service niche approach

Dr James Keirstead

Imperial College, UK

Urban sustainability indicators (USIs) play an important role in helping policy makers ensure the success of their cities. Indeed recent USI research has begun to shift from the development of individual metrics and frameworks to a more comprehensive assessment of their role within policy. This paper presents an evaluation of one such tool, the service niche approach to USIs. This method uses cross-cutting urban services such as water or energy provision to give a tangible focus to urban sustainability assessment and indicator development. The technique is applied to London's energy system and a series of indicators are collected and discussed. The results demonstrate that common USI problems (e.g. identifying urban boundaries, collecting comparable data) are not removed by using the service niche method, but the consequences of these short-comings can be highlighted more clearly. A key finding is the existence of a gap between 'good enough' policy indicators and more precise engineering models. The service niche approach arguably occupies an awkward middle ground between these two extremes, by trying to bring clarity and understanding to a complex field while remaining relevant to policy. It is therefore suggested the approach might be best used as a participatory learning tool, with system experts and policy makers working together to define, collect and interpret USIs.

Keywords: indicators, policy, service niche, urban sustainability, energy

1 Introduction

With approximately 50% of the world's population now living in cities (UN 2006), the sustainability of urban environments is a major concern. In these debates, cities can be seen as both 'problem creating nuclei' and 'problem solving nuclei' (Rotmans and Asselt 2000). On the one hand, continuing urban migration demonstrates that cities, as centres of economic and cultural activity, offer hope for significant quality of life improvements. However on the other hand, these gains can be threatened by local environmental degradation as well as social and economic inequalities (Starke 2007). Cities are also integral to global sustainability efforts as the goods and services required by urban populations necessitate exchanges of raw materials, processed goods and wastes with the wider world (UNDESA 1992, Satterthwaite 1999, McGranahan et al. 2005)

While urban sustainability is therefore a complex and multi-faceted area of study, one common theme is the need for indicators, i.e. "symbolic representations (e.g., numbers, symbols, graphics, colors) designed to communicate a property or trend in a complex system or entity" (Hák et al. 2007: 1). For those pursuing the path of sustainable development, these tools can provide valuable help when assessing progress towards desired goals, communicating with diverse audiences, providing early warning of potential problems and in many other applications (Alberti 1996). Yet despite the wealth of proposed urban sustainability indicators (USIs) and USI frameworks, review studies have concluded that "there are no indicator sets that are universally accepted, backed by compelling theory, rigorous data collection and analysis, and influential in policy" (Parris and Kates 2003: 559). This is primarily because the diversity of USI applications make the goal of a single overall urban sustainability indicator inappropriate; one is better advised to incorporate different viewpoints within a flexible customised framework (Walton et al. 2005, Holden 2006, Gasaparatos et al. 2007, Hák et al. 2007).

Unfortunately if not carefully addressed, the complexity and subjectivity of urban sustainability can lead to ambiguity, reducing the effectiveness of indicators as meaningful inputs to policy. These themes were explored in a previous paper and three main shortcomings in current practice were seen (Keirstead and Leach 2008). First, indicator selection was often found to emphasise data availability and measurability over the analytical validity of metrics. In selecting London's Quality of Life indicators for example, the indicator developers identified several issues that they "would like to measure, but for which there are no available data" (LSDC 2003). Secondly, indicators are often perceived as objective policy inputs when in reality they are highly subjective, both in their selection and interpretation (Astleithner et al. 2004). The third point is that the definition of urban sustainability underlying a set of indicators is often ambiguous. This may stem from the original definition of sustainable development itself (Giddings et al. 2002) but regardless of the precise cause, there is clearly a need to better define the principles guiding sustainability assessments (Haughton 1999, Pope et al. 2004, Hopwood et al. 2005).

The cumulative result of these issues is that USIs are arguably most effective as descriptions of urban state; their ability to provide meaningful inputs to policy debates is less certain. It was consequently suggested that the effectiveness of USIs might be improved by adopting a 'service niche' approach. This method uses vital cross-cutting urban services such as water or energy provision as a tangible focus for indicator selection and debate. Drawing from parallels in innovation literature, it was noted that the experience gained by developing these niche indicators could then be used to prompt wider questions about urban sustainability and to improve the analytical validity of associated indicators.

This paper begins to assess these claims, specifically by investigating whether the service niche approach can help to identify analytically valid indicators supported by quality data (or alternatively, to clarify the obstacles to achieving this goal). Using London's energy system as a case study, a list of relevant USIs is presented and the difficulties of collecting and interpreting the data are discussed. The conclusion then focuses on the implication of these findings for the use of service niche USIs as policy inputs.

2 Background

The service niche approach to USIs proposes that certain urban systems can provide a representative case study, enabling the selection of appropriate indicators and facilitating a discussion of urban sustainability principles and goals. The choice of urban system however is not specified; transport, water, waste and energy are all systems that have a significant impact on a city's sustainability and it is up to the user to decide which service is most relevant to their interests. Here, the focus will be on London's energy system owing to two relevant policies. First, the Greater London Authority has an active interest in sustainability indicators generally, as demonstrated by their Quality of Life and State of the Environment indicator reports (LSDC 2005, GLA 2007b). Secondly in 2004 energy was identified by then Mayor Ken Livingstone as "central to [his] policies on sustainable development" and an energy strategy released (GLA 2004b: i). Though originally an independent initiative, recent reforms have made the creation of a "climate change mitigation and energy strategy" a statutory duty, giving these issues added weight and permanence within the local policy environment (Greater London Authority Act 2007). This is particularly important as a new Mayor of London, Boris Johnson, was elected in May 2008. (The research presented here was conducted primarily in March 2008.)

2.1 London's urban energy system as a service niche

It has been suggested that a candidate system for the service niche approach should demonstrate three characteristics: pervasiveness, goal-orientation, and heuristic value (Keirstead and Leach 2008). A brief assessment of these features is now presented to ensure that London's energy system provides a suitable basis for a focused set of urban sustainability indicators.

The first criterion states that the proposed urban service system must be pervasive, i.e. linked to multiple aspects of urban sustainability. Intuitively there is little doubt that energy is central to urban life: as the energy strategy notes, London would not be "the city that it is – a hub of business, a focus for tourism and entertainment, a lively and dynamic place in which to live and work" without large reliable energy supplies (p. vii). However one should also assess the link between energy use and formal theories of urban sustainability. Considering the three domains of sustainability as an example, secure energy supplies are needed to power the city's economic activities, affordable energy services are necessary to avoid social problems such as fuel poverty, and burning fossil fuels to meet energy needs can create local and global environmental problems. The impacts of energy use also cover a range of temporal and geographic scales, thus linking with principle-based notions of sustainability (e.g. Haughton 1999). For these and other reasons, energy systems appear to provide an excellent focus for the development of urban sustainability indicators (OECD 1995, Kemmler and Spreng 2007).

The second question considers whether the proposed service niche supports the selection of tangible policy goals. It was noted earlier that current USI practice often features ambitious visions of urban sustainability that do not easily translate into firm and unambiguous targets (e.g. to 'improve' London's quality of life, LSDC 2005). However by focusing on a specific urban service, these goals can be clarified. For example, the general aspiration of improving the sustainability of an urban energy system can mean different things in different contexts; a city in a developing nation might wish to monitor the transition to higher-quality fuel sources (Barnes et al. 2005), whereas developed cities may focus more on climate change impacts (TCG 2008). The London energy strategy meets the goal-orientation requirement by presenting a number of policy goals and targets such as a 60% reduction in CO2 emissions by 2050 (versus 2000 baseline), having no occupied dwellings with a Standard Assessment Procedure rating of less than 30 by 2010, and providing at least 665 GWh of electricity and 280 GWh of heat from renewables by 2010 (GLA 2004b).

The final and perhaps most important issue relates to the service's heuristic value for exploring wider sustainability issues; in other words, by developing indicators for the proposed urban system, can policy makers be encouraged to define their vision of urban sustainability more clearly? Jaccard (2005: 6) briefly defines energy systems as "the combined processes of acquiring and using energy in a given society or economy". It is clear from such a definition that assessing an energy system's sustainability must consider both the supply and demand sides. However, even if one considers only the supply side, a number of fundamental judgements about the meaning of sustainability must be made. Would the city be considered sustainable if it was powered completely by electricity, a clean energy carrier which might however be generated by coal-fired stations far beyond the city's immediate environment? Should nuclear power be considered sustainable and if so, on what basis? How should the embodied energy of materials and services be counted? Each service niche will prompt its own set of questions but for the energy case, there are clearly a number of issues that help reveal a general vision of sustainability.

2.2 Indicator selection framework and method

Having established that London's energy system is an appropriate case study for the service niche approach, the next question is how to select relevant indicators. Current practice in USIs recommends that the indicator selection process should incorporate a wide range of viewpoints and to facilitate this, indicator goals and selection criteria must be transparent (AtKisson 1996, Stevens and Morris 2001, McAlpine and Birnie 2005, Bagheri and Hjorth 2007); Maclaren's "structured process for urban sustainability reporting" (1996) provides a template for this process and Ravetz's integrated urban assessment framework (2000) gives a theoretical basis for indicator selection. The key feature of this approach is its emphasis on the linkages within urban systems and its recognition that the state of the urban environment is the result of institutions and infrastructures trying to deliver a population's wants and needs. This resonates with the study of energy systems since energy is a derived demand: people do not consume kilowatt hours of electricity for their own sake; they want heat, light, and other services.

In a previous paper (Keirstead 2007), these methods were worked through in detail and an initial set of London energy metrics was proposed. However the paper was primarily exploratory in nature. It sought to determine the desired scope of urban energy system metrics and identified some methodological challenges, such as the need for complementary simulation and qualitative information. In contrast, the present paper seeks to evaluate these indicators as policy inputs; in other words, assessing whether the metrics are of sufficient quality to inform meaningful policy decisions. With this goal in mind, the original indicator list was revisited and some minor amendments made. All of the indicators have been drawn from publically available data sources, such as the Office of National Statistics, the Greater London Authority and the Department of Business, Enterprise and Regulatory Reform (specific references are given below where appropriate).

2.3 Urban energy system indicators for London

Table 1 shows the collected indicators for London's urban energy system, grouped under four main themes – drivers, activities, resources, and impacts. Each theme can be summarised by a set of core indicators or broken down into greater detail as needed; for example, the activities theme might be subdivided by energy sector into domestic, industrial or transport activities and the impact indicators can be categorized according to social, economic and environmental themes so as to map onto a triple-bottom line sustainability assessment.

Table 1. Urban energy system indicators for London

Theme	Sub-theme	Indicator
Drivers (30)	Demographics	Population
		Number of households
	Economic structure	Employment rate
		Weekly household income
		Wholesale and retail fuel prices (for coal, gas, oil and electricity; total 7 indicators)
		Competition in energy sector (Herfindal-Hirschmann index for electricity generation, wholesale gas, domestic electricity and gas sales; total 4 indicators)
		Inflation
	Local environment	Area
		Latitude and longitude
		Temperature
		Solar resource
		Wind speed
	Infrastructure	Car ownership
		Road and rail network length
		Investment in energy sector (R&D and general)
		Office space
		Number of dwellings
		Thermal quality of housing stock
Activities (22)	Domestic	% of delivered energy used for space and water heating, cooking, lights and appliances (4 indicators)
		Mean indoor temperature

		Household energy expenditure (total and by fuel, 5 indicators)
	Transport	Daily average trips (total and by mode, 6 indicators)
		Terminal passengers at airports
		Freight at airports
		Goods moved by road (London origin)
	Industrial	Industrial sector energy intensity
	Service/Commercial	Service sector output
		Service sector energy intensity
Resources (16)	Energy	Total primary energy supply
		Final consumption by fuel and total (7 indicators)
		Delivered energy by end-use (4 indicators)
		Delivered energy by fuel (4 indicators)
Impacts (9)	Social	Fuel poverty
		Road accidents
	Economic	Productivity
		Economic output
	Environmental	Local air quality (SO_2, NO_2, PM_{10})
		Greenhouse gas emissions (CO_2 and full Kyoto basket)

3 Assessing the indicators

There is insufficient space to present all of the indicators here and in any event, the goal of this paper is to consider how these metrics might inform policy decisions, not to evaluate the trends in London's energy system per se. The following discussion is therefore largely qualitative, highlighting the pitfalls within existing data sets and the potential areas for improvement rather than applying a quantitative method such as multi-criteria assessment to score each metric's performance.

3.1 Drivers

Driver indicators describe the determinants of energy-service demand and the metrics were selected primarily for their relevance to the major energy consumption sectors. For instance, trends in household numbers are particularly important as predictors of domestic energy demands (e.g. Boardman et al. 2005). In total four sub-themes were identified: demographics, economic structure, local environment and infrastructure.

One of the main challenges in collecting any indicator set is internal comparability and consistency. Geographically, only six of the thirty driver indicators explicitly referred to the target Greater London area; the other metrics had to be downscaled from data at the UK or England level, scaled up from specific points within London, or covered uncertain areas. This diversity raises an important question: do any of these boundaries suitably describe the functional extent of London's energy system? For example, the population of Greater London in 2000 was approximately 7.2 million but according to Columbia University's urban extents database, the true population of London at this time was closer to 12.8 million (SEDAC-CIESIN 2007). Similarly only two of London's five airports fall within the Greater London Authority boundary. This distinction between functional and administrative boundaries has policy implications as noted in the mayor's housing strategy (GLA 2004a), the mayor's Climate Change Action Plan (GLA 2007a) and the Urban Audits indicator database (Urban Audits 2007); without direct administrative control over the affected regions, policy success becomes increasingly dependent on coordination with other governance scales. Internal comparability and consistency affects the temporal spread of indicators as well, as seen in Figure 1. With consistent data available only within the past ten to fifteen years, longer-term multivariate analyses are likely to be difficult and arguably policy decisions can only be informed by conclusions drawn from general trends.

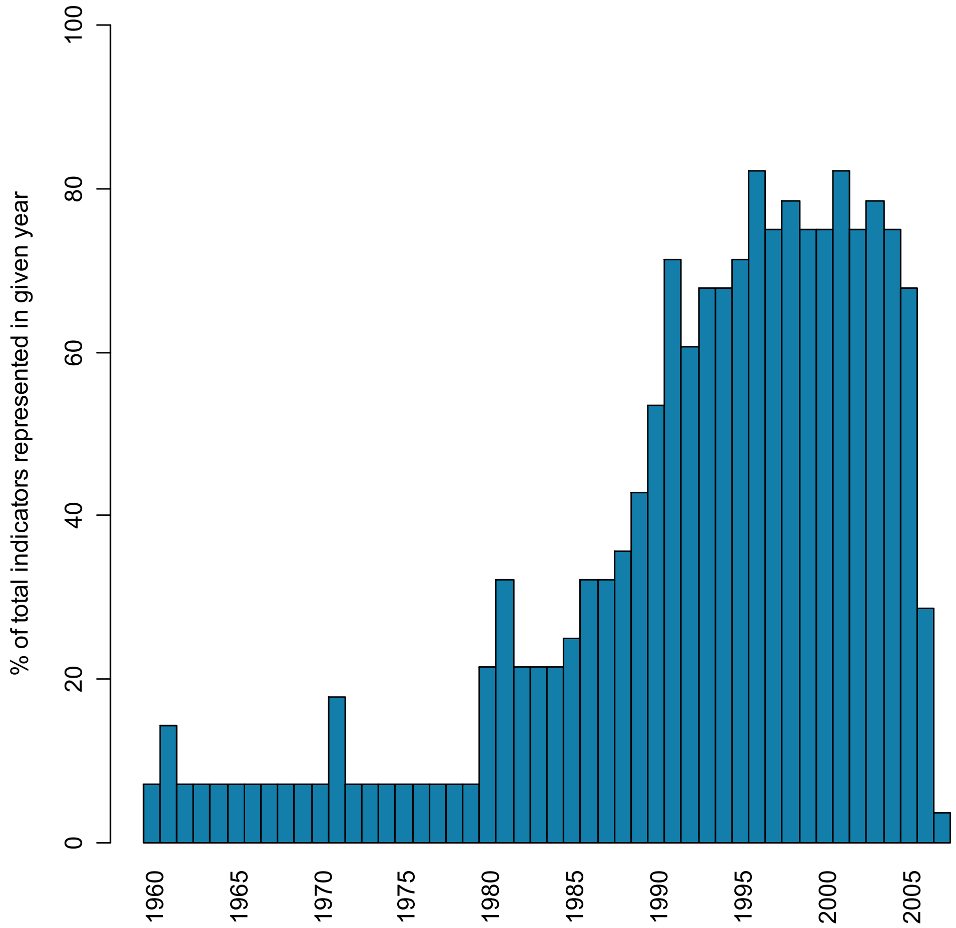


Figure 1. Temporal coverage of driver indicators, 1960-2007

Ideally one would like to be able to identify causal pathways from drivers through to the impacts of energy use. However sophisticated statistical analyses (such as structural equation modelling) are hampered by the lack of appropriate indicators for many drivers of urban energy use. In some cases, where the importance of the issue merits additional effort, further data processing might overcome this obstacle. For example, if a policy maker had a specific interest in housing, additional resources could be devoted to finding and analysing building fabric information from the English House Condition Survey. However the choice of indicators is also affected by the fact that some issues do not have accepted indicator definitions. Urban form and its influence on commuting patterns, transportation networks, and ecological health is a common theme in urban sustainability literature yet no readily available metric for London's form exist (Næss 1995, Burton 2002, Cook 2002, Shim et al. 2006, Gusdorf and Hallegatte 2007).

3.2 Activities

Activity indicators represent the use of energy services and while they do not measure energy consumption per se, they must be understood within the wider context of official energy statistics. Energy consumption can be measured in three ways: primary fuel inputs, final consumption (supplied energy) and final consumption (useful energy) (DTI 2006). Primary fuel inputs and supplied energy are the most common measures of an energy system's performance and these are considered in the resource indicators category. In contrast, useful energy analysis is important to understand how much of the inefficiencies within an overall system lay with end-use technologies instead of in upstream conversion and transmission processes. Unfortunately for those selecting activity indicators, "[s]tatistics on useful energy are not sufficiently reliable… there is a lack of data on utilisation efficiencies and on the purposes for which fuels are used." (DTI 2006: 21). As a result, useful energy consumption often cannot be directly measured and activity indicators must be drawn from proxy metrics, modelled data or other sources.

Energy statistics, both in the London energy strategy and UK publications, are typically presented in four main sectors: transport, domestic, commercial and industrial. In 1999 for example, London's total final energy consumption of 154 TWh was divided as follows: 21% transport, 44% domestic, 7% industrial, 29% commercial. For each of these sectors, there exists different approaches for creating activity indicators The domestic sector, for example, has a wealth of experience in bottom-up modelling using data on building fabric, the efficiency of lighting and appliances and knowledge of occupant behaviour to estimate the demand for energy services (Boardman et al. 2005, Lampaditou and Leach 2005, BRE 2006). In the transport sector, data on journeys by mode provide an effective measure of activity demand (TfL 2007) but the service and industrial sectors are more complicated, owing largely to their diversity. One potential solution is to use international standard industrial classification (ISIC) codes to categorize industrial outputs and estimate the likely energy consumption needed to produce each product (Nanduri et al. 2002). Official government statistics provide some idea of these demands nationally for both industrial and service sectors; for example in the service sector, approximately 55% of energy is used for heating, 15% for lighting, 10% for catering, 9% for hot water and 11% for other purposes (DTI 2002). However as national data, their relevance to London must be inferred or cross-referenced with other sources (e.g. GLA 2007c, LDA 2007).

3.3 Resources

Resource indicators measure the stocks and flows of energy, water and materials needed to meet activity demands. Only energy resources are considered here but in a more complete analysis, the city's boundary and energy profile would have a significant influence on the choice of metrics. For instance, the increased use of biofuels within a city would require a consideration of land use beyond immediate administrative boundaries in order to properly assess climate impacts (e.g. Reijnders and Huijbregts 2008). These issues can be addressed in part by ecological footprint analysis but there are outstanding questions regarding how this technique accounts for the boundaries of an urban area (BFF 2002) and the impact of energy systems (Ayres 2000).

As noted above, energy statistics can be calculated in different ways and the focus of the resource indicators is on primary and delivered energy. From a policy perspective, primary energy consumption is important largely at a national level and it has relevance to debates on resource extraction, energy security, infrastructure costs and global environmental impact. In contrast delivered energy plays a greater role in the urban context, where the use of clean transformed products such as electricity helps to remove the negative impacts of fuel consumption from the local environment. The analysis of urban energy consumption must account for both types of energy flow and their inter-conversion. Consequently care should be taken when preparing indicators to maintain disaggregated data on energy flows and their sources; electricity does not have the same environmental footprint if it comes from renewables or from coal-fired power stations.

Two significant studies provide delivered energy consumption statistics for London: one covering 1965 to 1991 (Chell et al. 1993) and the other 2003 (GLA 2003). These data are provided by sector and by fuel source and can be complemented by similarly detailed and well-documented data series for primary energy consumption at the national level (DTI 2006). The resource indicators benefit from significantly higher quality data than the other categories considered here, although there are still problems. These include data consistency (e.g. the difference in transport consumption between the pre-1991 and 2003 datasets, Figure 2) and analytical validity and adequacy (i.e. the collected data may not describe the energy consumption of the city according to its functional boundaries but is it nevertheless sufficient to make informed policy decisions?). Practical difficulties also exist when collecting these data; most of the information for the London studies came from major utility companies and according to the GLA (pers. comm.), commercial confidentially concerns and data preparation posed significant challenges.

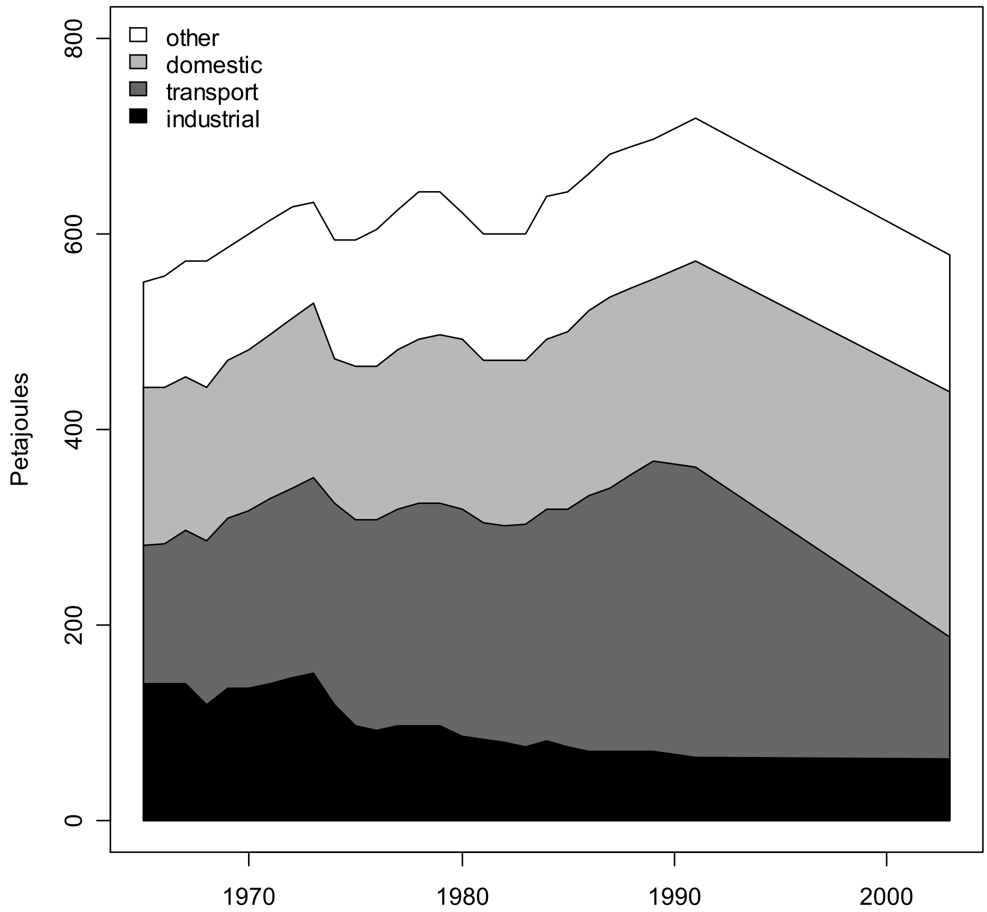


Figure 2. London's delivered energy consumption by end use (Chell et al. 1993, GLA 2003)

3.4 Impacts

Impact indicators describe the consequences of meeting activity demands with particular set of resource flows. Three types of impact were considered based on the traditional social, economic and environmental domains of sustainable development, thus providing a degree of compatibility with existing indicator frameworks.

Impact indicators are highly relevant to public sustainability debates as they ultimately demonstrate the success or failure of policy initiatives. However for this role to be fulfilled, two issues must be considered. First, the validity of the indicators themselves must be assessed. Goodhart's Law, which can be simply stated as 'what's counted counts' (McIntyre 2000), suggests that as evidence of policy success, these indicators can be subject to manipulation and misinterpretation. They must therefore meet the highest accountability standards so that claims made on their behalf are believable and that actions taken in response to them are appropriate. For example, optimizing a carbon emissions indicator by switching to biofuels may solve one problem, but create others in lost biodiversity and increased food prices (Anon 2006). Similarly, if it is claimed that policy success has been achieved through a particular intervention, understanding the linkages between indicators is important for validating this claim. For example, the UK's success in reducing carbon dioxide emissions during the 1990s was in large part due to a market-led switch to gas for electricity generation; direct policy action through efficiency initiatives and so on was less significant (Eichhammer et al. 2001). Mapping the links between indicators can also help to understand which policy options might have the biggest impact. Improving energy efficiency will help reduce carbon emissions but can also make a contribution to lowering the number of households in fuel poverty. A possible technique for recognizing these linkages is to assign points to each impact indicator if they are affected by a particular policy (Streimikiene and Sivickas 2008).

Impact indicators are often used to compare the performance of different cities and therefore the second issue pertains to the applicability of these metrics outside the local policy environment. One of the goals of the London Sustainable Development Commission was to develop indicators that could demonstrate London's international position in urban sustainability. However for such comparisons to be valid there must be accepted methodologies for calculating impact indicators. For some issues, this choice of indicator may be straight-forward; the Eco99 life-cycle assessment methodology for example evaluates the health impacts of pollution by normalization against internationally recognized damage thresholds (PRE 2006). Other issues are more difficult though and standards may be hotly contested, as in the international methodologies for greenhouse gas emissions which do not include aviation or marine emissions. At an urban scale, the C40 group of world cities is currently developing a comparable emissions inventory method for use by its members (C40 2008).

4 Discussion

The presented indicator set was not intended to represent an exhaustive analysis of London's urban energy system. However by collecting these metrics and considering their potential use in a sustainability assessment, two major themes can be seen. First, the effectiveness of the proposed indicators is subject to limitations of data availability and analytical validity, as with any other indicator set. Secondly, the service niche approach can be useful to help understand where these shortcomings lay and the consequences for policy.

4.1 Data constraints and analytic validity

As the collected indicators were drawn from readily available data sources (in much the same way that London compiles its urban sustainability metrics), it is not surprising that significant data availability issues were found. These included the lack of indicators for key parts of the energy systems (e.g. activities and useful energy consumption), the lack of data at desired spatial and temporal resolutions (e.g. driver indicators), and inconsistencies in scale and method (e.g. how to account for direct and indirect emissions). In some cases, these obstacles could be overcome with additional time, effort and resources. For example, national statistics data sets provide information on domestic activities which have been used to build detailed models of energy use in this sector (e.g. Lampaditou and Leach 2005). However, for city authorities with constrained budgets and schedules, it seems unlikely that more than one or two indicators could benefit from this kind of further refinement. London's Energy and Carbon Dioxide Emissions inventory (GLA 2003) is an example of such a product.

How these data quality constraints affect the validity of indicators as policy inputs can be seen as a two-part problem. The first issue is the validity of these indicators as accurate representations of the state of the urban energy system. In this case, data limitations have significant consequences. Without consistent long-term time series across the full spectrum of the energy system, it is not possible to build statistically-valid models of indicator interactions. This limits our understanding of the system to one or two key variables or trends. The second issue is the veracity of the indicators when cited by policy makers in support of their actions. Here the consequences are arguably less severe, as policy debates will always be hotly contested. But clearly without well-established data collection standards or the support of statistical models, it becomes increasingly difficult to determine whether city X or Y has the "better" energy system.

Although further study is required, these results suggest that the identified problems are not unique to the energy system. For example, it was shown that understanding the performance of London's energy system arguably requires a functional definition of the city, while most of the data were collected using administrative boundaries. These difficulties are not specific to the energy niche; Thames Water, which provides London's water and waste water services, operates over a large area including parts of Surrey, Gloucestershire, Wiltshire, and Oxfordshire and so determining how the firm's performance data can be broken down and attributed to London is similarly problematic (Thames Water 2005). This may represent a fundamental paradox of the service niche approach: any candidate system that is sufficiently pervasive in theory is likely to be physically sprawling in practice, blurring the boundaries of data collection.

4.2 The role of the service niche approach

It is of course naïve to think that perennial issues in urban sustainability indicators can be overcome simply by introducing a new framework. Policy makers will always have to make decisions using incomplete information. However this analysis has helped to clarify some of the uncertainty, highlighting those areas that would benefit most from robust data collection standards or further analysis. For example, resource indicators appear to follow well-defined protocols whereas activity indicators rely more heavily on proxies or modelled data.

These insights suggest some tension between the potential role of the service niche approach and traditional USI applications. This can be understood by placing urban sustainability "data" applications on a continuum. At one end lies the current use of indicators within policy processes: readily-available metrics chosen largely to demonstrate a concern for sustainability issues and to provide an overview of the challenges facing a particular city. At the other end however, there are the detailed analytical models of experts which take significant resources to develop, supply with data, and interpret. The Tyndall Centre's integrated urban assessment model is one such example, exploring the consequences of flooding in London with sophisticated GIS, climate and regional economic modelling frameworks.

The service niche approach lies somewhere along this axis, seeking to provide more rigour and analysis than a general indicator set and yet trying to work within the policy constraints that might exclude a detailed expert analysis. In practice, this means that policy makers and experts should work together more closely. The input of experts could be used to identify the desired and achievable levels of analytical detail, to determine effective proxy measures where data are unavailable, to map the links between indicators, to ensure comparability between data sets, and ultimately to help policy makers draw valid conclusions from available and imperfect indicators. Of course, owing to the conflict between political accountability and indicator performance, these experts should remain independent from policy makers.

5 Conclusion

This paper used the service niche approach to urban sustainability indicators to structure an evaluation of the challenges faced when compiling indicators of London's energy system. It was shown that, while the approach cannot overcome obstacles such as a lack of readily accessible data, it can help to make these shortcomings explicit. Persistent data collection issues (e.g. inconsistencies in spatial and temporal scope, the need to use proxy measures) mean that expert input is arguably needed to interpret available information and to help policy makers determine the quality of data required for effective policy decisions.

These findings indicate a tension between an accurate engineering or functional models of an urban energy system and a more simplified policy model. The service niche approach to USIs might therefore be most effective as a tool for meso-scale sustainability assessments. It offers more detail than a generic sustainability assessment, helping to focus stakeholders on tangible sustainability questions, and yet additional expert input and data collection would be required to provide a high-quality issue-specific analysis. The service nice approach could structure these interactions between policy makers and experts, helping to identify the boundaries between policy and engineering models of the city and ultimately improving indicator design and implementation processes.

The author's second paper in this volume will now explore this hypothesis in detail, asking members of London's energy policy community how a service niche indicator framework might be integrated into daily decision-making processes.

6 References

Alberti, M. (1996) Measuring urban sustainability, 'Environmental Impact Assessment Review', volume 16, issue 4-6, 381-424.

Anon (2006) A paler shade of green, 'The New Scientist', volume 191, issue 2570, 3.

Astleithner, F., A. Hamedinger, N. Holman and Y. Rydin (2004) Institutions and indicators – the discourse about indicators in the context of sustainability, 'Journal of Housing and the Built Environment', volume 19, issue 1, 7-24.

AtKisson, A. (1996) Developing indicators of sustainable community: lessons from Sustainable Seattle, 'Environmental Impact Assessment Review', volume 16, 337-350.

Ayres, R. U. (2000) Commentary on the utility of the ecological footprint concept, 'Ecological Economics', volume 32, issue 3, 347-349.

Bagheri, A. and P. Hjorth (2007) Planning for sustainable development: a paradigm shift towards a process-based approach, 'Sustainable Development', volume 15, issue 2, 83-96.

Barnes, D. F., K. Krutilla and W. F. Hyde (2005) "The urban household energy transition: social and environmental impacts in the developing world", Washington, D.C.: Resources for the Future.

BFF (2002) City limits: a resource flow and ecological footprint analysis of Greater London. Best Foot Forward, Oxford. http://www.citylimitslondon.com/downloads/Complete%20report.pdf.

Boardman, B., S. Darby, G. Killip, M. Hinnells, C. Jardine, J. Palmer and G. Sinden (2005) 40% House. Environmental Change Institute, Oxford.

BRE (2006) Domestic energy fact file. Building Research Establishment. http://projects.bre.co.uk/factfile/TenureFactFile2006.pdf.

Burton, E. (2002) Measuring urban compactness in UK towns and cities, 'Environment and Planning B: Planning and Design', volume 29, issue 2, 219-250.

C40 (2008) C40 Cities: Climate Leadership Group. Accessed: 11 July 2008, from http://www.c40cities.org/.

Chell, M., D. Hutchinson, London Research Centre. and Commission of the European Communities. Urban and Regional Energy Management Programme. (1993) "London energy study: energy use and the environment", London: London Research Centre.

Cook, E. A. (2002) Landscape structure indices for assessing urban ecological networks, 'Landscape and Urban Planning', volume 58, issue 2-4, 269-280.

DTI (2002) Energy consumption in the United Kingdom. Dept of Trade and Industry, London. http://www.berr.gov.uk/files/file11250.pdf.

DTI (2006) Digest of UK Energy Statistics. Accessed: 22 January 2007, from http://www.dti.gov.uk/energy/statistics/publications/dukes/page29812.html.

Eichhammer, W., U. Boede, F. Gagelmann, E. Jochem, J. Schleich, B. Schlomann, J. Chesshire and H.-J. Ziesing (2001) Greenhouse gas reductions in Germany and the UK - coincidence or policy induced? An analysis for international climate policy. Accessed: 8 February 2006, from http://www.isi.fhg.de/e/publikation/wallfall/co2report-isi-e-final.pdf.

Gasaparatos, A., M. El-Haram and M. Horner (2007) The argument against a reductionist approach for assessing sustainability. SUE-MoT International Conference on Whole Life Urban Sustainability and its Assessment. Glasgow Caledonian University, Glasgow.

Giddings, B., B. Hopwood and G. O'Brien (2002) Environment, economy and society: fitting them together into sustainable development, 'Sustainable Development', volume 10, issue 4, 187-196.

GLA (2003) London Energy and Carbon Dioxide Emissions Inventory 2003. Greater London Authority, London.

GLA (2004a) London Housing Strategy 2005: Draft evidence base. Accessed: 3 October 2007, from http://www.gos.gov.uk/497417/docs/202207/221963/sec1.pdf.

GLA (2004b) The Mayor's Energy Strategy. Accessed: 12 August 2007, from http://www.london.gov.uk/mayor/strategies/energy/index.jsp.

GLA (2007a) Action today to protect tomorrow: The Mayor's climate change action plan. Greater London Authority, London. http://www.london.gov.uk/mayor/environment/climate-change/ccap/index.jsp.

GLA (2007b) State of the Environment report. Accessed: 1 October 2007, from http://www.london.gov.uk/mayor/environment/soereport.jsp.

GLA (2007c) Economic development publications. Accessed: 4 October 2007, from http://www.london.gov.uk/gla/publications/economy.jsp.

Greater London Authority Act (2007). c.24, United Kingdom. http://www.opsi.gov.uk/Acts/acts2007/pdf/ukpga_20070024_en.pdf.

Gusdorf, F. and S. Hallegatte (2007) Compact or spread-out cities: Urban planning, taxation, and the vulnerability to transportation shocks, 'Energy Policy', volume 35, issue 10, 4826-4838.

Hák, T., B. Moldan and A. L. Dahl (eds) (2007) Sustainability indicators: a scientific assessment. SCOPE Series. London: Island Press.

Haughton, G. (1999) Environmental Justice and the Sustainable City, 'Journal of Planning Education and Research', volume 18, issue 3, 233-243.

Holden, M. (2006) Urban indicators and the integrative ideals of cities, 'Cities', volume 23, issue 3, 170-183.

Hopwood, B., M. Mellor and G. O'Brien (2005) Sustainable development: mapping different approaches, 'Sustainable Development', volume 13, issue 1, 38-52.

Jaccard, M. K. (2005) "Sustainable Fossil Fuels: The Unusual Suspect in the Quest for Clean and Enduring Energy", Cambridge: Cambridge University Press.

Keirstead, J. (2007) Selecting sustainability indicators for urban energy systems. In: M. Horner, C. Hardcastle, A. Price and J. Bebbington (eds.) International Conference on Whole Life Urban Sustainability and its Assessment Glasgow

Keirstead, J. and M. Leach (2008) Bridging the gaps between theory and practice: a service niche approach to urban sustainability indicators, 'Sustainable Development', volume 16, issue 5, 329-340.

Kemmler, A. and D. Spreng (2007) Energy indicators for tracking sustainability in developing countries, 'Energy Policy', volume 35, issue 4, 2466-2480.

Lampaditou, E. and M. Leach (2005) Evaluating participation of residential consumers in demand responses programs in the UK. In: F. Bartiaux and A. G. Selnæs (eds.) ECEEE Summer Study, Mandelieu, France, 1271-1282.

LDA (2007) Economic Development Strategy. Accessed: 4 October 2007, from http://www.lda.gov.uk/server/show/nav.001005006004.

LSDC (2003) Sixth meeting held on 17 December 2003. Accessed: 13 November 2006, from http://www.london.gov.uk/mayor/sustainable-development/minutes/lsdc-min171203.pdf.

LSDC (2005) 2005 report on London's quality of life indicators. London Sustainable Development Commission, London.

Maclaren, V. W. V. (1996) Urban sustainability reporting, 'Journal of the American Planning Association', volume 62, issue 2, 184-202.

McAlpine, P. and A. Birnie (2005) Is there a correct way of establishing sustainability indicators? The case of sustainability indicator development on the Island of Guernsey, 'Local Environment', volume 10, issue 3, 243-257.

McGranahan, G., P. Marcotullio, X. Bai, D. Balk, T. Braga, I. Douglas, T. Elmqvist, W. Rees, D. Satterthwaite, J. Songsore and H. Zlotnik (2005). Urban systems. In: R. Hassan, R. Scholes and N. Ash (eds.), "Millenium Ecosystem Assessment: Ecosystems and Human Well-being, Current State and Trends, Volume 1". Washington: Island Press, pp. 795-825.

McIntyre, M. E. (2000) Audit, education, and Goodhart's law: Or, taking rigidity seriously Accessed: 4 October 2007, from http://www.atm.damtp.cam.ac.uk/people/mem/papers/LHCE/dilnot-analysis.html.

Næss, P. (1995) Central dimensions in a sustainable urban development, 'Sustainable Development', volume 3, issue 3, 120-129.

Nanduri, M., J. Nyboer and M. Jaccard (2002) Aggregating physical intensity indicators: results of applying the composite indicator approach to the Canadian industrial sector, 'Energy Policy', volume 30, issue 2, 151-163.

OECD (1995) "Urban energy handbook: good local practice", Paris: Organisation for Economic Co-operation and Development.

Parris, T. M. and R. W. Kates (2003) Characterizing and measuring sustainable development, 'Annual Review of Environment and Resources', volume 28, 559-586.

Pope, J., D. Annandale and A. Morrison-Saunders (2004) Conceptualising sustainability assessment, 'Environmental Impact Assessment Review', volume 24, issue 6, 595-616.

PRE (2006) Eco-indicator 99. Accessed: 18 October 2006, from http://www.pre.nl/eco-indicator99/default.htm.

Ravetz, J. (2000) Integrated assessment for sustainability appraisal in cities and regions, 'Environmental Impact Assessment Review', volume 20, issue 1, 31-64.

Reijnders, L. and M. A. J. Huijbregts (2008) Palm oil and the emission of carbon-based greenhouse gases, 'Journal of Cleaner Production', volume 16, issue 4, 477-482.

Rotmans, J. and M. B. A. V. Asselt (2000) Towards an integrated approach for sustainable city planning, 'Journal of Multi-Criteria Decision Analysis', volume 9, issue 1-3, 110-124.

Satterthwaite, D. (1999) "The Earthscan reader in sustainable cities", London: Earthscan.

SEDAC-CIESIN (2007) Global Rural-Urban Mapping Project (GRUMP). Accessed: 1 May 2007, from http://sedac.ciesin.org/gpw/index.jsp.

Shim, G. E., S. M. Rhee, K. H. Ahn and S. B. Chung (2006) The relationship between the characteristics of transportation energy consumption and urban form, 'Annals of Regional Science', volume 40, issue 2, 351-367.

Starke, L. (ed) (2007) State of the World 2007: Our urban future: a Worldwatch Institute Report on progress towards a sustainable society. London: Earthscan.

Stevens, K. and J. Morris (2001) Struggling toward sustainability: considering grassroots development, 'Sustainable Development', volume 9, issue 3, 149-164.

Streimikiene, D. and G. Sivickas (2008) The EU sustainable energy policy indicators framework, 'Environment International', volume 34, issue 8, 1227-1240.

TCG (2008) The Climate Group: About Us. Accessed: 11 July 2008, from http://www.theclimategroup.org/index.php/about_us/.

TfL (2007) Annual travel reports. Accessed: 4 October 2007, from http://www.tfl.gov.uk/corporate/about-tfl/publications/1482.aspx.

Thames Water (2005) Thames Water Sewerage and Clean Water Boundary Map. from http://www.thameswater.co.uk/cps/rde/xbcr/SID-8813AD40-88765DDC/corp/sewerage-and-clean-water-boundary-map.pdf.

UN (2006) World urbanization prospects: the 2005 revision population database. Accessed: 18 September 2006, from http://esa.un.org/unup/.

UNDESA (1992) Agenda 21. Accessed: 12 April 2007, from http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21toc.htm.

Urban Audits (2007) Urban Audit: City Profile: London. Accessed: 3 October 2007, from http://www.urbanaudit.org/CityProfiles.aspx.

Walton, J. S., M. El-Haram, N. H. Castillo, R. M. W. Horner, A. D. F. Price and C. Hardcastle (2005) Integrated assessment of urban sustainability, 'Engineering Sustainability', volume 158, issue ES2, 57-65.

7 Acknowledgements

The financial support of BP via the Urban Energy Systems project at Imperial College is gratefully acknowledged.

London's energy system: prospects for using the service niche approach in current indicator practice

Dr James Keirstead

Imperial College, UK

The use of cross-cutting urban services such as energy or water provision has been proposed as a way of improving the performance of urban sustainability indicators (USIs). However for significant benefits to be realised, the new approach must be adopted by policy makers. This paper presents interviews with stakeholders from London's energy policy community and uses a diffusion of innovation framework to examine how the service niche approach fits with existing practice and consequently whether it is likely to be adopted in practice. The results suggest that while the technique resonates with current practice, it cannot overcome traditional barriers such as a lack of political will or resources alone. Two distinct expansion strategies are proposed to help build experience and leverage the full potential of the technique: replication (the creation of multiple service niche assessments in complementary urban systems) and extrapolation (extending the detailed niche activities of a local policy maker into regional or national levels). In both cases, experts could play a central role in coordinating the overall effort, collecting relevant data and analysing the aggregate results with policy makers. Therefore while the method is unlikely to be adopted as a wholesale replacement of existing strategies, it could be beneficial as a complementary assessment method.

Keywords: indicators, policy, service niche, urban sustainability, energy

1 Introduction

The sustainability of urban environments is a major contemporary issue as over 50% of the world's population now lives in cities (UN 2006). However while urban sustainability debates often focus on technical issues such as environmental degradation or poverty (Starke 2007), the ability of urban and national governments to respond to these problems and introduce effective policy measures is equally important. It is often the role of urban sustainability indicators (USIs) to bridge this gap between issues and policy by measuring the state of the complex urban system and communicating it to relevant stakeholders (Alberti 1996, Hák et al. 2007). However it has been noted that current practice in USIs is often unable to achieve this goal for three main reasons: an emphasis on data availability and measurability criteria in indicator selection over analytical validity, the casting of subjective indicators as objective policy inputs, and the ambiguous definition of urban sustainability underlying indicators and their interpretation (Keirstead and Leach 2008). It was consequently suggested that by using service niches, i.e. cross-cutting urban systems such as water or energy provision, urban sustainability indicators could be given a tangible focus and this could lead to an improved understanding of urban sustainability within policy circles.

As discussed in the author's complementary paper (this volume), an analysis has been performed of how the service niche approach might shape the process of selecting and interpreting USIs. This initial evaluation found that the method fills a meso-scale analytical role, being more focused than a broad sustainability assessment but lacking sufficient detail and expertise for a targeted issue-specific policy response. Independent experts have a major role to play in achieving this balance, by guiding the selection, interpretation and validation of niche indicators so as to improve public accountability and indicator performance (e.g. by highlighting topics where scarce resources should be focused for better data collection). However if this vision is to be realised, one must first understand the extent to which the service niche approach fits with the existing routines of policy makers, advisory groups and other stakeholders.

The present paper therefore reviews current energy policy and indicator processes in London and evaluates whether the service niche approach might be adopted in practice. Using the results of interviews with representatives of the London energy policy community, the paper seeks to answer two specific questions. First a diffusion of innovation framework is used to assess how the service niche approach compares to existing indicator practice: specifically how do the principles underlying the service niche approach, i.e. the pervasiveness, heuristic-value and goal-orientation of a proposed service niche, relate to current urban sustainability policy in London? Secondly the paper considers how the particular niche of urban energy systems might be expanded within London in order to promote a wider sustainability assessment. The concluding discussion draws these themes together and assesses the method's prospects more generally.

2 Background and methodology

The service niche approach proposes that certain urban systems can provide a representative case study, enabling the selection of meaningful indicators and facilitating a discussion of urban sustainability principles and goals. It is not restricted to any one urban service; transport, water, waste and energy are all systems which run through urban life and have a significant impact on a city's sustainability. London's energy system has been selected as the focus of these papers on account of the Greater London Authority's (GLA) interest in both sustainability indicators generally and energy issues in particular (GLA 2004, LSDC 2005). The indicator set developed in the previous paper addresses these energy and climate goals, and while the metrics were found to be insufficient for a detailed analysis of London's energy system, they do form a plausible set of policy-relevant indicators; hence they have been used as the basis of these interviews.

To assess how the service niche approach fits with existing policy processes in London, Rogers's diffusion of innovation framework (2003) has been used. (Actor-network theory or other perspectives may offer a more complete view of the adoption process but diffusion of innovation was chosen here for its simplicity.) Often used to describe technology adoption, many of the concepts in this theory are also applicable to the adoption of processes or frameworks. The theory suggests that adoption decisions are generally based on a user's perceptions of five characteristics of the innovation relative to existing options: its relative advantage, compatibility, complexity, trialability and observability. The relevance of these traits to indicator practice can be seen in the existing literature, as in this example of the compatibility concept: "Policy-makers only take that knowledge into consideration that does not cause too great tension with their values… These values are embedded in 'policy frames' or 'policy theories'. Knowledge that does not fit into these policy theories is not agreeable and will be discarded." (Veld't 2004, cited in Dahl 2007: 127)

Interviews were conducted with major stakeholders in the London energy policy community to assess these attributes. Figure 1 illustrates the main actors within this network, demonstrating that a range of national, regional, local, private and public agencies are involved. The contributions of these groups range from setting the framing conditions in central government ministries through to the direct actions of local partnerships and boroughs. Given the number of agencies and the complexity of their roles, the interviews focused on groups located at the intersection of these linkages (for the more peripheral agencies, a review of published policy documents was used to understand their contributions). In total, six individuals were identified representing the Government Office for London (central/regional government), the Greater London Authority and a London borough (regional/local government), the London Energy Partnership and the London Sustainability Exchange (non-governmental organizations).

Hour-long semi-structured interviews were conducted with the respondents in March 2008 (i.e. prior to the May 2008 mayoral election). They explored the general policy context for London's energy system, as well as specific questions about the relative merits of the service niche approach and the proposed indicator set.

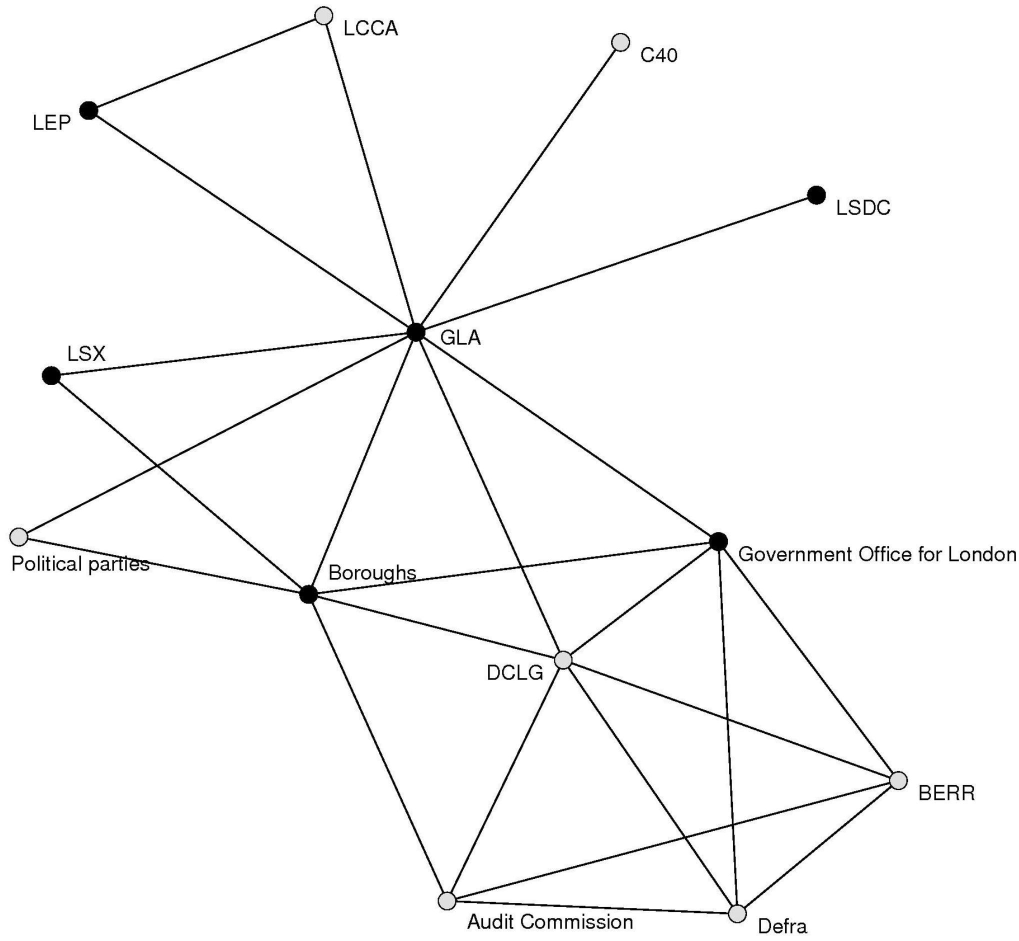


Figure 1. London's energy policy network showing the main actors mentioned in this paper; interviewed organizations are marked by the dark circles. LEP – London Energy Partnership; LCCA – London Climate Change Agency; GLA – Greater London Authority; C40 – Cities Climate Leadership Group; LSDC – London Sustainable Development Commission; LSX – London Sustainability Exchange; DCLG – Department of Communities and Local Government; BERR – Department of Business Enterprise and Regulatory Reform; Defra – Department for Environment, Food and Rural Affairs

3 Evaluating the goals of the service niche

Service niches are those systems integral to a city's overall sustainability such as energy, water, waste, or transportation. Since a number of urban services might intuitively form an appropriate basis for a focused sustainability indicator set, it was suggested that three criteria be used to evaluate a service's candidacy. These state that a service niche should be pervasive (i.e. touching on many aspects of urban sustainability), goal-orientated (i.e. tied to specific policy objectives) and possessing heuristic value (i.e. could be used to prompt a wider discussion of underlying urban sustainability principles) (Keirstead and Leach 2008). The first part of the interviews therefore focused on the relevance of these concepts to London's energy policy community.

3.1 Pervasiveness

The service niche approach requires that a candidate service reflect the diversity of the sustainability agenda. Ideally this should include relevance both to stated sustainability policies (if they exist in a particular city) and to theoretical debates on urban sustainability; it is not enough that a service simply has social, economic and environmental dimensions. As discussed in the previous paper, the pervasiveness requirements appear to have been met for London's energy system as it has been explicitly acknowledged by the GLA as being central to London's overall sustainability goals and it reflects the breadth of both triple-bottom line and principle-based notions of sustainability. However in practice, it was found that in London the potentially broad range of energy and sustainability issues has been largely restricted to a single issue, climate change.

The interviewees emphasised that climate change was the biggest part of their daily roles, particularly since recent reforms have made "climate change mitigation and energy" a statutory responsibility of the GLA (Greater London Authority Act 2007). However it was noted that issues such as fuel poverty are also part of the energy agenda and that too much focus on climate change mitigation risks promoting an incomplete representation of not just energy policy, but also sustainability more generally. As one respondent noted,

> *"I'm pretty militant against using carbon as a proxy for sustainability – it is not. Energy is part of the issues that we have to address and carbon is something that's very important for us to be discussing, but in terms of climate change and sustainability … it's as much to do with that, as it is to do with all those other things [e.g. community cohesion, adaptation]"*

Another interviewee revealed how the focus on climate change mitigation is related to changing theoretical interpretations of urban sustainability. While the Brundtland definition of sustainable development is well known in policy circles (WCED 1987), it now appears that this perspective is gradually being replaced by a more issue-specific focus. In particular, one respondent noted that "I think increasingly sustainable development is moving down the agenda and being replaced by One Planet Living" (see WWF International and BioRegional 2008). This concept identifies 10 sustainability principles or issues, of which climate change is one. This finding suggests that if policy makers are looking for more tangible representations of sustainability, then the pervasiveness of a service niche might be best assessed by evaluating its relevance to these ten sustainability principles (e.g. by scoring a niche against each particular topic, Streimikiene and Sivickas 2008).

A longer term perspective on these issues came from a local government official who noted that shifts in policy priorities have always been a feature of local energy policy. He observed that since the 1950s, London's energy policy has variously emphasised local air pollution, energy security, fuel poverty and now climate change. These priorities change over time and therefore an agency choosing an urban service for indicator selection will have their evaluation of its pervasiveness shaped by the pressing issues of the day and by contemporary definitions of what it means to be sustainable. The difficulty is that these particular issues might not be ideal for a long-term sustainability assessment and effort will be needed to maintain consistency by placing such short-term priorities within the context of long-term goals.

3.2 Goal-orientation

The balance between climate change and other issues also relates to the goal-orientation of a particular service niche. This attribute seeks to ensure that the selected indicators for a particular niche are relevant to current policy debates and can be translated into specific actionable policies. This latter point is particularly important as one respondent noted that there is a risk that "establishing the indicators, determining the methodologies becomes the climate change task". In other words, it is not enough to identify a niche and select indicators that are relevant to policy goals; the niche should also have the potential to deliver real action.

To understand how this relates to London, it is worth providing some detail on the current role of indicators within local government processes. In the UK, local councils (i.e. within London, the 32 boroughs and the City of London) are required to report on their performance through two mechanisms. The first is the Comprehensive Area Assessment (CAA, was Comprehensive Performance Assessment). It is coordinated by the independent Audit Commission and strong performance on this exercise gives councils additional flexibility to pursue their policy goals, while also demonstrating the quality of council services to the local electorate. The CAA now consists of 198 indicators on which local authorities must report annually. Local Area Agreements (LAA) form a second initiative and these are essentially contracts between central government (represented in London by the regional Government Office for London, GOL) and the local councils. In negotiation with GOL, London councils can set three-year priority targets for up to 35 of the 198 CAA indicators (plus 18 statutory education targets) and meeting these goals provides the council with additional resources and a higher standing in the Audit Commission assessment. As the Greater London Authority derives its authority from a parliamentary act and is distinct from local councils, its role in both of these processes is largely advisory, working with GOL and councils to ensure that the agreed targets are broadly consistent with the mayor's strategies and priorities.

The most important thing about this structure is that it provides firm lines of accountability. The CAA and LAA indicators define the goals that local council officials are most concerned with, and given limited resources, they may be unable to pursue other priorities. Yet as one interviewee noted, "there are some activities that are worth doing even though you don't have an immediate result, if you don't have an indicator to measure your success". Indeed a common theme in the interviews was that while indicators may help monitor the state of policy in these priority areas, there remains a gap between the process of collecting and reporting on the indicators and the actual implementation of related policy measures:

> *"In the end there are people, a considerable number of people and resources expended going through this kind of this process, [and] very few people actually focused on doing, delivering the targets"*

> *"I think [the GLA] are focused on putting in place some excellent strategies and mechanisms but I don't think we're seeing perhaps the delivery or monitored delivery clearly yet"*

The interviewees stressed that these comments were not intended as criticisms of specific organizations but a recognition that councils have only limited resources with which to implement sustainability programmes and the GLA has limited policy control over the actions of the boroughs (primarily through the planning system). Indeed this gap between the broad aims of indicators and the realistic potential for policy intervention has been recognized internally by these organizations. For example, the GLA's Climate Change Action Plan identifies the potential carbon savings that can be made by the coordinated action of the GLA and the boroughs; however in order to meet its 2050 target of a 60% reduction in CO_2 emissions, 50% of the savings will require supportive central government policies, for example in energy markets (GLA 2007).

It was originally hypothesised that service niche indicators could help to overcome these obstacles by highlighting potentially neglected areas of policy and helping to target scarce resources more effectively. However while most respondents acknowledged that better quality data would help, they did not feel it was the major barrier to action. After reviewing the proposed indicator set for example, one respondent noted "So, you know, I think that's fine but you've just got to accept that that's not going to solve all your problems." The lack of implementation resources remains a central part of the sustainability dilemma and therefore assessing the goal-orientation of a service niche should emphasise the ability of the sector to actually deliver a change, rather than just having general relevance to policy interests.

3.3 Heuristic value

The final criterion is the extent to which a proposed service niche can help policy makers think about and elucidate the principles guiding their sustainability assessments. The energy indicators outlined here were drawn from existing data sources and seemed to reflect a disconnected, triple-bottom line interpretation of sustainability. It was suggested that identifying the links between metrics, adding overall system metrics and incorporating greater expert input could be useful in trying to move beyond this perspective to a more integrated assessment. The interviews explored these issues further and sought to understand the role of politicians in interpreting the indicators.

As noted earlier, one of the themes was the shift from Brundtland-style conceptualizations of sustainability towards more issue-focused approaches, based on climate change or the topics of One Planet Living. Some of these issues have strong links with established sustainability principles, such as geographic equity (Haughton 1999), and to explore this idea further, respondents were asked specifically about the extent to which footprint analysis techniques (e.g. Rees and Wackernagel 1996) informed their choice and interpretation of indicators. It was felt that there was "a general trend" towards these concepts, thanks largely to increased public awareness of issues such as food miles and carbon footprints. However the extent to which these ideas were adopted in policy debates was dependent largely on the local councils themselves: that is, the broad priorities of elected authorities and the specific support of a few key individuals. Respondents from local and regional government emphasised the role of council chief executives in particular in promoting these wider assessments:

> *"I think it [the move towards ecological footprinting] is from them [the councils], political as well as higher, you know, senior management aspirations. And for some, especially like Kingston and Sutton who are sort of outer London, who don't get the sort of funding or attention... it's a good way of sort of positioning themselves as leaders... portraying back to their residents and businesses that we're environmental leaders"*

However the promotion of these concepts through political channels arguably represents a double-edged sword. On the one hand, a politician's exposure to their electorates encourages them to respond to changing social concerns; similarly research has shown that unelected chief executives, while striving for impartiality, feel that the authority of their office is ultimately derived from this electoral mandate (JRF 1997). On the other hand though, there are conflicting incentives between introducing a more rigorous footprint definition of sustainability in order to promote one's green credentials and the actual performance on this measure. One respondent recognized the perils of this situation, noting:

> *"It's amazing what you can get done if you're prepared not to take the credit for it and that's the problem with the politician, they need to take the credit for it."*

If a politician does indeed need to take credit for the performance of indicator, then one must critically consider both the choice of the indicator (i.e. would a metric knowingly be chosen if it makes a city look bad, even if it does have theoretical advantages?) and the level of sophistication with which the metric is described and analysed (i.e. to what extent would a politician support a detailed analysis that might reveal that a metric improved not because of local policies, but perhaps in spite of them?).

These issues are particularly sensitive when comparing cities with one another. The C40 group represents many of the world's leading cities and they are currently working to develop a comparable methodology for calculating urban greenhouse gas emissions (C40 2008), raising questions about the practicality and validity of such comparisons. One interviewee related two anecdotes highlighting these challenges. In the case of transport, a comparative study of London and Paris found that each city measured the length of rail track – a seemingly simple indicator – differently, owing to whether the track was available at peak time, whether it was shared with the national rail network and so on. Similarly a comparative waste study with Tokyo found that the Japanese capital had significantly lower waste generated per capita, which on further analysis turned out to be an artefact of how recycled materials were classified by each city.

These examples therefore illustrate that the heuristic value of a service niche is likely to be only as strong as the political will to explore sustainability issues further, rather than representing an inherent feature of the service. To the extent that these systems may be used for comparative analyses, there will also be system-specific indicator definition issues that need to be resolved and these may be easier for some services than for others.

4 Expanding the service niche

At first glance, the interview results suggest that the service niche approach is unlikely to be adopted in current circumstances. This is primarily a practical issue, as it was shown that the relative advantage of the technique is limited; current indicators – although imperfect – were seen as being sufficient to inform effective policy action and the main barrier to success was insufficient resources for implementation, a lack of political interest, or the restrictions of institutional frameworks. However no immediate incompatibilities between the service niche approach and existing practice were seen. The complexity of the indicator set was not dissimilar to existing toolkits and the observed shift to climate change or other discrete issues, rather than the nebulous concept of sustainability, is compatible with the goal-orientation aspect of the service niche approach.

Since policy priorities change over time in response to constituent demands and unexpected events, it has been suggested that indicator frameworks must be able to provide both short-term flexibility as well as long-term stability and familiarity (Rickard et al. 2007). The strategic niche management literature offers one solution to this dilemma: the promotion of coordinated niche experiments that provide opportunities for the development of working relationships and shared visions of success (Weber 2003, Wüstenhagen et al. 2003). Such experiments also fit with diffusion of innovation theory, as they enable potential adopters to trial the innovation or observe its use by others. Two strategies for expanding the single energy niche discussed here are now considered: replication and extrapolation.

4.1 Replication: multiple service niches

The first strategy for expanding a service niche is simply to replicate the experiment by developing niche indicators for different services. This paper has focused on the energy system but other candidate systems such as water, waste and transport have been mentioned as well. While each will have distinct and concrete policy contexts that affect their contribution towards an overall sustainability assessment, exploring these alternative systems provides policy makers with an opportunity to try the technique in their field or observe its use by others.

Consider the waste system as an example. During the consultation period for 2007 Greater London Authority Act, the Mayor of London sought to gain authority for waste matters in addition to his existing powers in local air quality, spatial planning and other issues (GLA 2006). However this move was largely resisted by the boroughs and ultimately central government decided to make only minor changes to the waste arrangements for London (DCLG 2006). The policy network for waste issues is therefore largely arranged between central government and the local waste authorities (waste authorities exist as both single- and joint-borough activities); the mayor does have a waste strategy but it does not have statutory backing as for energy and climate. In practice this means that an indicator set for waste will span stakeholders with different concerns and data collection boundaries from the energy system, providing an opportunity to expand the network of sustainability stakeholders and introduce new perspectives. However the lack of a central implementation agency (such as the London Climate Change Agency or London Energy Partnership in the case of energy) means that there is no obvious linkage within the GLA for interpreting the policy relevance of a waste indicator set and its relationship to energy or other niche indicators. The challenge therefore is to develop a structure which can capture the policy and data diversity of different sustainability issues while at the same time promoting a city-wide understanding of sustainability (i.e. the concern of Rickard et al. about framework stability versus flexibility).

The interviews highlighted three possible models for managing and coordinating different niche experiments within a cohesive structure. The first is the advisory board model, as represented by the London Sustainable Development Commission (LSDC 2008). The LSDC is an independent agency whose board is comprised of individuals from private, public and voluntary sector organizations with interests in London's sustainability. Their task is to advise the mayor on sustainability issues and monitor progress via a city-wide sustainable development framework and indicator set; however they do not implement policy themselves. The second model is the coordinating board, which provides an internal forum for different work streams to meet and ensure the compatibility of their efforts; it is not independent like the advisory board. This model is currently used within the

GLA, where the Strategy Coordinating Group enables representatives from each of the mayor's major strategies to meet and ensure that their respective efforts are broadly compatible; however they do not use common indicator sets. The final model is that of the Audit Commission, which provides an independent forum and a validation service for member organizations. Like the LSDC, the Audit Commission provides an indicator framework but rather than being developed internally, its content is determined by central government departments through the CAA exercise (e.g. indicators from Defra on climate change, from BERR on skills and economy, etc.). The Audit Commission therefore acts to validate the performance of local councils against the goals of central government, i.e. an 'invigilator'.

Table 1. Alternative strategies for coordinating replicated service niche indicator activities

Strategy	Example	Pros	Cons
Advisory board	LSDC	Independent, develops its own sustainability framework and indicator set, provides expert advice to policy makers	No implementation resources
Coordinating board	GLA Strategy Coordination Group	Detailed knowledge of each niche experiment, close links with policy makers	Comprised of interested parties, no common indicator set
Invigilator	Audit Commission	Independent, validates performance of third parties against a common indicator framework	Indicator framework is externally determined, limited capacity for providing niche-specific expert advice

The differences between these models are summarized in Table 1 but it should be noted that these structures have more in common than providing a structure for coordinating indicator initiatives; they also offer potential data collection advantages. For example, one of the interviewees from the GLA indicated that he had access to most of the data he needed when analysing the performance of London's energy system and making decisions. However his knowledge of where to look, how to interpret the data, and who to ask for clarifications was the result of having worked within the organization for the past decade. Having a central data repository would help avoid such limitations of institutional memory though care would be needed to ensure that collected data were not excessively homogenised. An example of this is the GLA's energy and climate statistics, which present airport emissions separately from other sectors (as they are not included within international climate agreements); users can then include or exclude these data as they wish. Since the goal of replicating these niche experiments is to understand the variety of sustainability interpretations, collecting related data and assessing its limitations is arguably part of this exercise.

4.2 Extrapolation: the role of national political parties

Expanding the service niche does not necessarily require the replication of indicator sets as described above. An alternative strategy is extrapolation; that is, extending the sustainability debate vertically into the national political system. As the interviews found, local councils and their electorates play a significant role in shaping the sustainability agenda and in the UK, local government is closely tied with the national political parties. London in particular has provided a visible arena for policy experimentation and debate, be it Margaret Thatcher's cancellation of the Greater London Council, New Labour's disputes with Ken Livingstone over his mayoral candidacy, or the recent revival of Conservative Party fortunes alongside Boris Johnson's mayoral victory (Pimlott and Rao 2002, Rawnsley 2008). This interaction provides a unique opportunity for London's policy makers, both at the GLA and borough levels, to try new initiatives which if they are successful can be adopted and promoted by the national political parties. Similarly, national parties can use their connections within local government to promote sustainability initiatives from the top down.

An example of this can be seen in case of urban renewable energy. In 2003, the London Borough of Merton introduced a planning ordinance which stated that non-domestic buildings over 1000 m2 were "expected" to provide at least 10% of their energy needs from on-site renewables (LBM 2008). This innovative policy was a local borough initiative but it took its lead from central government guidance on renewable energy. Since then, the so-called Merton Rule has been adopted by 31 other local councils and it is under consideration by many more. However since first declaring their interest in expanding this policy nationwide in June 2006, central government support has wavered. In September 2007, concerns about the burdens that mismatched local policies might place on housing developers led to the suggestion that such local initiatives should be banned in favour of a single national strategy. But following a backlash from the media, learned societies and other stakeholders, the policy once again has central government support (DCLG 2007).

This example suggests that the extrapolation model contains an inherent tension between local and national policy agendas. Just as different cities change from concerns about local pollution to global issues (McGranahan et al. 2005), residents of a local community may be more concerned with recycling provision or the quality of neighbourhood parks rather than global climate change or regional water balances. Alternatively as described above, central government may be concerned with coherent housing policy while local authorities are focused on doing what they can to address climate change. Identifying the boundaries between these two systems will be important so that one can determine who has initiated a policy experiment and ultimately who is responsible for its success or failure.

The processes by which a service niche is extrapolated to a different policy scale should therefore be transparent and flexible. Transparency is a central principle of urban sustainability and the development of successful indicator systems demands that the views of different community groups are taken into account in a fair manner (e.g. Haughton's (1999) "procedural equity"). Local communities will be unlikely to support policy initiatives if they are perceived as being part of partisan political experimentation at a different scale and transparency also helps to keep policy makers to their word. In the case of the Merton Rule above, an interviewee noted that central government became "a hostage to [its] ambitions" when it was seen to be saying that climate change is important on the one hand and yet discouraging innovative local initiatives on the other. This episode also reinforces the notion that such experiments are vital for providing flexibility to an indicator or sustainability programme:

> *"It's policy diversity at a local municipal borough level driving the process of innovation and whereas if you have a flat one size fits all approach, where do you get the innovation from?"*

Overall then, extrapolation is a promising strategy for building on a single service niche and applying its lessons to a wider field of analysis. However like the replication strategy, the challenge is to ensure that these activities are coordinated, leveraging the links between local and national policies while at the same time preserving both local independence and overall strategic direction.

5 Conclusion

This paper set out to assess the potential use of the service niche approach to urban sustainability indicators within London's energy policy community. Using a diffusion of innovation framework and the results of interviews with key stakeholders, the results suggested that there is not a compelling case for adopting the service niche approach at present. Nonetheless the approach is broadly compatible with current practice and further steps might be taken to demonstrate its potential advantages. These expansion strategies might include creating niche indicator sets for other urban services ("replication") or coordinating action with other levels of government ("extrapolation"). Both approaches are likely to require additional service-specific expert input and changes to the role of key agencies so that these experiments can be successfully coordinated and collected data can be made available to interested parties.

Many opportunities also exist for further academic work on the subject. The material presented here was specific to London's energy system and by applying the service niche approach to different cities and service niches, a base of experience could be developed that would help to validate and improve the technique. Other work could focus on trialling the proposed niche expansion strategies or assessing the necessary extent and form of expert input (e.g. possible means for describing the links between metrics or summarizing overall system performance). The literature stresses that sustainability debates and indicators require pluralities of data, methods, and knowledge (Norgaard 1989, Ravetz and Funtowicz 1999, Gasaparatos et al. 2007); these steps represent contributions to this goal.

The overall lesson of this study is that perennial obstacles to improved USIs cannot be overcome simply by introducing a new indicator framework. Shifting political agendas, a lack of implementation resources, and inconsistencies in collected data are just some of the persistent issues which make it difficult to promote integrated sustainability assessment on a crowded urban agenda. However tools such as the service niche approach should not be ignored as they represent fresh ways of thinking about difficult problems which may in time yield valuable insights. With the benefit of further research and a wider set of case studies, the service niche approach may become a useful tool for addressing the diverse needs of policy makers.

6 References

Alberti, M. (1996) Measuring urban sustainability, 'Environmental Impact Assessment Review', volume 16, issue 4-6, 381-424.

C40 (2008) C40 Cities: Climate Leadership Group. Accessed: 11 July 2008, from http://www.c40cities.org/.

Dahl, A. L. (2007). Methodological aspects. In: T. Hák, B. Moldan and A. L. Dahl (eds.), "Sustainability indicators: a scientific assessment". London: Island Press.

DCLG (2006) The Greater London Authority: The Government's Final Proposals for Additional Powers and Responsibilities for the Mayor and Assembly. Accessed: 10 July 2008, from http://www.communities.gov.uk/publications/citiesandregions/greaterlondon5.

DCLG (2007) Planning Policy Statement: Planning and Climate Change. Department of Communities and Local Government, London. http://www.communities.gov.uk/documents/planningandbuilding/pdf/ppsclimatechange.pdf.

Gasaparatos, A., M. El-Haram and M. Horner (2007) The argument against a reductionist approach for assessing sustainability. SUE-MoT International Conference on Whole Life Urban Sustainability and its Assessment. Glasgow Caledonian University, Glasgow.

GLA (2004) The Mayor's Energy Strategy. Accessed: 12 August 2007, from http://www.london.gov.uk/mayor/strategies/energy/index.jsp.

GLA (2006) The Mayor of London's response to the ODPM's consultation paper on the powers and responsibilities of the Mayor and Assembly. Accessed: 9 February 2007, from http://www.london.gov.uk/mayor/powers/docs/response.pdf.

GLA (2007) Action today to protect tomorrow: The Mayor's climate change action plan. Greater London Authority, London. http://www.london.gov.uk/mayor/environment/climate-change/ccap/index.jsp.

Greater London Authority Act (2007). c.24, United Kingdom. http://www.opsi.gov.uk/Acts/acts2007/pdf/ukpga_20070024_en.pdf.

Hák, T., B. Moldan and A. L. Dahl (eds) (2007) Sustainability indicators: a scientific assessment. SCOPE Series. London: Island Press.

Haughton, G. (1999) Environmental Justice and the Sustainable City, 'Journal of Planning Education and Research', volume 18, issue 3, 233-243.

JRF (1997) The role of the local authority chief executive. Accessed: 10 July 2008, from http://www.jrf.org.uk/knowledge/findings/government/G55.asp.

Keirstead, J. and M. Leach (2008) Bridging the gaps between theory and practice: a service niche approach to urban sustainability indicators, 'Sustainable Development', volume 16, issue 5, 329-340.

LBM (2008) The Merton Rule. Accessed: 14 July 2008, from http://www.themertonrule.org/.

LSDC (2005) 2005 report on London's quality of life indicators. London Sustainable Development Commission, London.

LSDC (2008) The London Sustainable Development Commission. Accessed: 4 July 2008, from http://www.londonsdc.org/.

McGranahan, G., P. Marcotullio, X. Bai, D. Balk, T. Braga, I. Douglas, T. Elmqvist, W. Rees, D. Satterthwaite, J. Songsore and H. Zlotnik (2005). Urban systems. In: R. Hassan, R. Scholes and N. Ash (eds.), "Millenium Ecosystem Assessment: Ecosystems and Human Well-being, Current State and Trends, Volume 1". Washington: Island Press, pp. 795-825.

Norgaard, R. B. (1989) The case for methodological pluralism, 'Ecological Economics', volume 1, issue 1, 37-57.

Pimlott, B. and N. Rao (2002) "Governing London", Oxford: Oxford University Press.

Ravetz, J. and S. Funtowicz (1999) Editorial: Post-normal science - an insight now maturing, 'Futures', volume 31, issue 7, 641-646.

Rawnsley, A. (2008) David Cameron's success brings his biggest challenge. The Observer, London. http://www.guardian.co.uk/commentisfree/2008/may/04/davidcameron.conservatives.

Rees, W. and M. Wackernagel (1996) Urban ecological footprints: Why cities cannot be sustainable - and why they are a key to sustainability, 'Environmental Impact Assessment Review', volume 16, issue 4-6, 223-248.

Rickard, L., J. Jesinghaus, C. Amann, G. Glaser, S. Hall, M. Cheatle, A. A. Le Kama, E. Lippert, J. McGlade, K. Ruffing and E. Zaccai (2007). Ensuring policy relevance. In: T. Hák, B. Moldan and A. L. Dahl (eds.), "Sustainability indicators: a scientific assessment". London: Island Press.

Rogers, E. M. (2003) "Diffusion of Innovations" (5th Edition), New York: The Free Press.

Starke, L. (ed) (2007) State of the World 2007: Our urban future: a Worldwatch Institute Report on progress towards a sustainable society. London: Earthscan.

Streimikiene, D. and G. Sivickas (2008) The EU sustainable energy policy indicators framework, 'Environment International', volume 34, issue 8, 1227-1240.

UN (2006) World urbanization prospects: the 2005 revision population database. Accessed: 18 September 2006, from http://esa.un.org/unup/.

Veld't, R. i. (2004) The importance of being a boundary worker. . Bridging the Gap: Information for Action, Dublin, Ireland.

WCED (1987) "Our common future", Oxford: Oxford University Press.

Weber, W. M. (2003) Transforming large socio-technical systems towards sustainability: on the role of users and future visions for the uptake of city logistics and combined heat and power generation, 'Innovation', volume 16, issue 2, 155-175.

Wüstenhagen, R., J. Markard and B. Truffer (2003) Diffusion of green power products in Switzerland, 'Energy Policy', volume 31, issue 7, 621-632.

WWF International and BioRegional (2008) One Planet Living. Accessed: 3 July 2008, from http://www.oneplanetliving.org/.

7 Acknowledgements

The financial support of BP via the Urban Energy Systems project at Imperial College London is gratefully acknowledged.

Future changes in the carbon intensity of grid electricity and its effect on the carbon emissions from domestic electric heating solutions

Philip James, Dr Rodger Edwards

University of Manchester, UK

In response to the issue of climate change, the UK is committed to meeting its share of an EU target that 20% of the EU's energy should come from renewables by 2020. Further, it has set a target in the Climate Change Act to reduce UK greenhouse gas emissions by at least 80% by 2050. Meeting these targets will lead to a significant reduction in the carbon intensity of the UK's electricity supply.

This paper assesses the carbon emissions factor for grid electricity currently used in the Standard Assessment Procedure (SAP) for calculating carbon emissions from dwellings and the Simplified Building Energy Model (SBEM) used for calculating carbon emissions from non-domestic buildings. This currently used figure is found to be around 20% lower than those based on the most recent data. However, the carbon emissions factor for grid electricity is expected to fall. Based on the future electricity generation energy mix, as projected by studies conducted for the UK Government's Renewable Energy Strategy Consultation, carbon emissions factors have been predicted here for 2020. The central estimate is 0.294 $kgCO_2/kWh$.

Based on this projection, the carbon emissions of heat pumps are assessed if used for the provision of space heating and hot water within both existing and new-build dwellings. Comparisons are made with other domestic heating solutions and current issues with the practical application and energy efficiency maximisation of heat pumps are discussed. The results show that with the predicted carbon intensity of grid electricity in 2010, carbon emissions savings of around 30% can be made by switching from an efficient gas boiler to a heat pump. Further, carbon savings of around 60% could be achieved by 2020 if the carbon intensity of grid electricity is reduced as predicted through the greater use of renewable electricity generation.

It is concluded that accurate and regularly updated short- and long-term projections of the carbon emissions factor for grid electricity are needed to better inform decisions based on the carbon emissions from different building services solutions.

Keywords: carbon emissions factor, domestic dwellings, electric heating, grid electricity, heat pumps

Introduction

In response to the issue of climate change, the UK government has signed up to a series of targets for the reduction of greenhouse gas emissions. These include the UK's Kyoto Protocol commitment to reduce greenhouse gas emissions by 12.5% below 1990 levels over the period 2008-2012 (DEFRA 2008); a UK national target to reduce CO_2 emissions by 20% below 1990 levels by 2010 (DEFRA 2008); an EU target for a 20% reduction below 1990 levels in EU greenhouse gas emissions by 2020 – rising to 30% if there is an international agreement (European Commission 2008); and a commitment in the Climate Change Act to reduce the UK's greenhouse gas emissions by at least 80% below 1990 levels by 2050 (Great Britain 2008).

Given the commitment to these targets policies must be devised to meet them. To this end the UK government has committed to an EU target to source 20% of the EU's energy from renewables by 2020. The UK's contribution to the achievement of this target is to source 15% of its energy from renewables by 2020 (BERR 2008).

If these targets are met it could result in a reduction in the carbon emissions from the generation of grid electricity. The carbon emissions from, or 'carbon intensity', of grid electricity can be measured by the carbon emissions factor. This value, as used here, gives the average amount of carbon emitted per unit of electricity generated by all sources that supply the grid. It is measured in kilograms of carbon dioxide per kilowatt-hour ($kgCO_2/kWh$).

The carbon emissions factor of grid electricity is integral to the calculation of carbon emissions from buildings. The current figure used in the Standard Assessment Procedure (SAP) for calculating carbon emissions from dwellings is 0.422 $kgCO_2/kWh$ (BRE 2008). The same figure is used in the Simplified Building Energy Model (SBEM) and other approved commercial software used for calculating carbon emissions from non-domestic buildings (ODPM 2006). This figure is assessed here for its accuracy.

If the above targets for carbon emissions reductions and the increased use of renewable energy sources are met, the carbon emissions factor of grid electricity should decrease. Projections of the future electricity generation energy mix have been produced for the government's Energy White Paper (DTI 2007) and for the Renewable Energy Strategy Consultation (BERR 2008). Based on these projections predicted values for the carbon emissions factor of grid electricity in 2020 are presented.

If the carbon emissions factor of grid electricity falls in future years this has implications when considering the whole-life carbon emissions from a range of building services solutions. Perhaps most important are the implications for the carbon emissions from electric heating solutions. Electric heating may have traditionally been considered a high carbon emissions heating solution, however, with greater use of heat pumps in the UK this could change. Therefore, based on the carbon emissions factors presented in this study, the current and predicted future carbon emissions from heating using heat pumps are compared with those from an efficient gas boiler.

The carbon intensity of grid electricity

As stated, the CO_2 emission factor for grid electricity used by SAP and SBEM is 0.422 $kgCO_2/kWh$. This figure is derived from research by the Building Research Establishment (BRE). As they state, "The expected average annual emission factor for grid electricity of 0.422 $kgCO_2$/kWh is based on the expected mix of electricity supply for the average of the Central Growth/Low Price and Central Growth/High Price scenarios between 2005 and 2010 from the DTI energy projections presented in Energy Paper 68 which have been adjusted to take account of expected transmission and distribution losses. Although there will be variations in the actual emission factors at different times of the day, it is appropriate to use an average value for SAP calculations" (Pout 2005).

Therefore, the carbon emissions factor is not based on the actual electricity generation energy mix but on the average of Department of Trade and Industry (DTI) projections for 2005 and 2010 (DTI 2000). The electricity generation energy mix predicted by the DTI in 2000 is shown in table 1. Also shown in table 1 are the actual electricity generation figures for 2005 on a gross supplied basis from the Digest of UK Energy Statistics (BERR 2008a). This data shows a much higher proportion of coal-fired electricity generation, less gas-fired electricity generation, and less generation from renewables than was predicted for 2005 by the DTI projections used to calculate the carbon emission factor for SAP and SBEM.

As would be expected, the DTI projections have been updated on several occasions since 2000, with the most recent update in November 2008 (DECC 2008). As shown in table 1, the updated Central projection for 2010 predicts a much higher proportion of coal-fired electricity generation, less gas-fired electricity generation, less nuclear generation, and less generation from renewables than was predicted for 2010 by the DTI projections used to calculate the carbon emission factor for SAP and SBEM.

Table 1. Projected electricity generation by fuel type for the Central Growth/Low Price and Central Growth/High Price scenarios in 2005 and 2010 (DTI 2000). Also shown, the actual electricity generation figures for 2005 on a gross supplied basis (BERR 2008) and the updated Central projection for 2010 (DECC 2008).

TWh	**CL 2005**	**CH 2005**	**CL 2010**	**CH 2010**	**DUKES Gross Supplied 2005**	**Updated Central 2010**
Coal	54	96	38	83	129	120
Oil	0	0	0	0	4	1
Gas	196	142	236	173	149	132
Nuclear	86	86	66	66	75	63
Renewable	22	22	43	41	17	33
Import	12	13	7	8	-	14
Storage	-	-	-	-	3	2
Total	370	360	390	371	377	366

The carbon emissions per kWh of electricity from coal-, oil- and gas-fired generation are dependent on the amount of carbon released from the fuel burnt and the amount of electricity generated as a result. An adjustment can be made to this figure to account for grid transmission losses, giving the carbon emissions per kWh of delivered electricity. This calculation is summarised in table 2 using the

2005 figures for fuel used in electricity generation and the gross electricity supplied. As shown, the carbon emissions per kWh from coal-fired electricity generation are over twice those from gas-fired generation. This is due to the higher carbon emissions per kWh of fuel burnt and the lower efficiency of coal-fired power stations. Therefore, the underestimation of the reliance on coal-fired electricity generation in the period 2005-2010 means that the carbon emission factor for grid electricity used in SAP and SBEM is too low.

Using the actual electricity generation energy mix for 2005 and the updated projection for 2010 from table 1, and using the carbon emissions per kWh of delivered electricity for coal-, oil- and gas-fired generation from table 2, updated carbon emission factors for grid electricity have been calculated and are shown in table 3. In the calculation the electricity supplied from imports and storage is excluded and zero carbon emissions are assumed from renewable and nuclear generation. The updated carbon emissions factors are around 25% higher than the value of 0.422 kgCO_2/kWh used in SAP. As shown in table 3, the updated figures calculated here compare well with estimates from other sources.

Table 2. The figures for calculating CO_2 emissions per kWh of delivered electricity from coal-, oil- and gas-fired generation. *Assumes 13% grid losses (MTP 2008).

Fuel	**Carbon emissions / kWh fuel burnt (kgCO_2/kWh) (Pout 2005)**	**2005 Fuel used for electricity generation (TWh) (BERR 2008a)**	**2005 Gross supplied electricity (TWh) (BERR 2008a)**	**Carbon emissions / kWh electricity generated (kgCO_2/kWh)**	**Carbon emissions / kWh electricity delivered (kgCO_2/kWh)***
Coal	0.298	379	129	0.878	1.009
Oil	0.258	16	4	0.909	1.044
Gas	0.188	328	149	0.414	0.476

Table 3. Estimates of the carbon emissions factor for grid electricity for 2005 and 2010. Also shown, carbon emissions factors calculated for the Market Transformation Programme and by DEFRA.

Source	**Carbon emission factor (kgCO_2/kWh)**	
	2005	**2010**
James and Edwards (2009)	0.549	0.530
Market Transformation Programme (MTP 2008)	0.548	0.520
DEFRA (2008a)	0.535	-

If the carbon intensity of grid electricity continues to decrease beyond 2010 then it is valid to ask how long it will be before the carbon emissions factor reaches the value of 0.422 kgCO_2/kWh currently used in SAP and SBEM. Projections up to 2030 were made for the Market Transformation Programme (MTP 2008). These were based on the electricity generation energy mix projected by the 'central price, central carbon savings' scenario used in the Energy White Paper (BERR 2008b) (see table 4). A carbon emissions factor of 0.423 $kgCO_2/kWh$ was predicted for 2020.

However, the electricity generation energy mix projections used by the MTP do not include the policy implications resulting from the Renewable Energy Strategy Consultation. This consultation and the resulting policies are central to the achievement of the target for 15% of the UK's energy to come from renewables by 2020.

Studies by Sinclair Knight Merz (SKM 2008) and Redpoint (2008) were conducted for the Renewable Energy Strategy Consultation (BERR 2008). Their projections for the electricity generation energy mix in 2020 are shown in table 4. The carbon emissions factors resulting from these projections were calculated and are also shown in table 4. The calculation uses the carbon emissions per kWh of delivered electricity for coal-, oil- and gas-fired generation from table 2 and assumes zero carbon emissions from renewable and nuclear generation. The results indicate a significant reduction in the carbon emissions factor from grid electricity would occur as a result of the projected increases in renewable electricity generation. The central estimate from this study is the figure of 0.294 $kgCO_2/kWh$ calculated using the SKM 'medium-renewables' scenario.

In the calculation of the above figure no account has been taken of future changes in the efficiency of coal-, oil- or gas-fired electricity generation. The MTP study did take account of efficiency improvements in coal- and gas-powered plant and the higher efficiency of newly built plant. This explains the lower carbon emissions factor calculated by the MTP study, as compared with that based on the MTP generation percentages but using the carbon emissions / kWh of delivered electricity for each fuel from table 2.

Given that no account is taken of improved coal- and gas-powered plant efficiency, the carbon emissions factors presented for the SKM and Redpoint projections could be considered overestimates. However, given the lower percentage of generation from coal and gas that is predicted by the SKM and Redpoint studies, less new coal- and gas-powered plant will be required. Therefore, the higher efficiency of new coal- and gas-powered plant will have less effect on the predicted carbon emissions factors based on these studies.

Table 4. Projected carbon emissions factors for grid electricity in 2020 based on projections of the electricity generation energy mix by the MTP, SKM and Redpoint. For MTP the figure given was calculated by that study; the figure in parentheses was calculated from the generation percentages using the carbon emissions / kWh of delivered electricity for each fuel from table 2).

2020	**MTP**	**SKM**			**Redpoint**
		Low	**Medium**	**High**	
Coal (%)	19.3	20.1	16.8	12.9	15.0
Oil (%)	0.3	0.0	0.0	0.0	0.0
Gas (%)	53.1	26.3	23.2	19.7	42.0
Nuclear (%)	6.8	11.5	11.4	11.0	4.0
Renewables (%)	15.5	34.0	43.8	50.0	36.0
Average carbon emissions factor ($kgCO_2/kWh$)	0.423 (0.474)	0.357	0.294	0.239	0.362

Heat Pumps

Heat pumps, as used for domestic heating, extract thermal energy from the surrounding environment and upgrade it to a higher, more useful temperature. A heat pump consists of a compressor and carefully matched evaporator and condenser coils. A refrigerant liquid circulates within the system and evaporates when absorbing heat from the outside environment. It is possible to extract heat from the air at temperatures as low as -20^{o}C. The resulting refrigerant gas is then compressed by an electric motor, raising its temperature. The heat is passed via a heat exchanger in the condenser into water and can be used to provide space heating and hot water (NHBC 2007).

Heat pumps are defined by the source of the heat taken from the outside environment. In a Ground Source Heat Pump (GSHP) heat is absorbed from the ground. Below about 2 metres the ground temperature varies little over the year and is stable at around 10-12^{o}C. The system may be closed-loop, where a fluid is circulated through pipes buried in the ground (called a ground loop). The ground loop may be buried vertically or horizontally. When the heat energy has been extracted by the heat pump, the fluid is re-circulated back through the ground loop. It is important to demonstrate that the heat extracted from the ground over a whole year is less than the expected solar gain to that area - this defines the required area of the ground loop. Alternatively, an open loop system may be used where groundwater is taken from one area, the heat extracted by the heat pump, and the cooled water released back into the ground at a different location (NHBC 2007).

In an Air Source Heat Pump (ASHP) heat is absorbed from the outside air. Air temperature is less stable than ground temperature. It will also be lowest when space heating demand is highest. Therefore, ASHPs typically have a lower Seasonal Performance Factor (the average ratio of energy produced to energy consumed) than GSHPs. As figure 1 shows, the Coefficient of Performance of an ASHP is significantly reduced at lower ambient air temperatures.

Normal gas central heating systems typically have a flow temperature of 75^{o}C and a return temperature of 65^{o}C, however, heat pumps typically have a flow temperature of 50°C and a return temperature of 35°C, therefore, the heating delivery system needs to be designed with this in mind. In new builds, under-floor heating will often be specified as the most effective way to deliver low-grade heat. However, the most up-to-date heat pumps can produce water up to 65°C thereby reducing dependency on supplemental systems and avoiding problems of *legionella* in the hot water supply (Sanyo 2008). Though as figure 1 shows, heat pumps are more efficient at lower output flow temperatures. Typical Seasonal Performance Factors for heat pumps may be in the range of 2:1 to 5:1 (NHBC 2007).

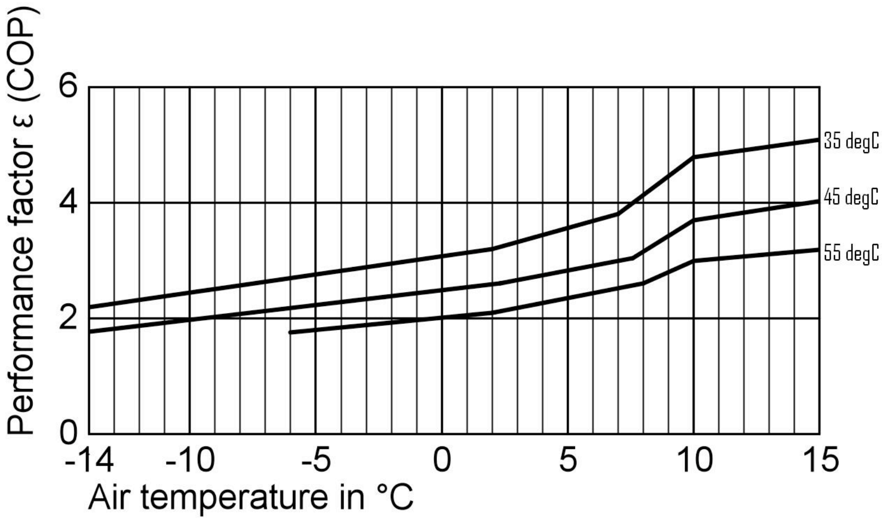


Figure 1. The efficiency of an Air Source Heat Pump at different ambient air temperatures and with different output flow temperatures (Source: Viessmann (2006)).

Comparing the efficiency of heat pumps and gas boilers

Figure 2 compares the CO_2 emissions incurred per kWh of heat produced by a highly energy efficient gas boiler and by heat pumps operating at a range of efficiencies. Three carbon emissions factors are used for the grid electricity powering the heat pumps: firstly, the MTP projection for 2010 of 0.520 $kgCO_2$/kWh (see table 3); secondly, the current figure used in SAP of 0.422 $kgCO_2$/kWh; and thirdly, the figure of 0.294 $kgCO_2$/kWh calculated from the SKM 'medium-renewables' scenario projection for 2020 (see table 4).

The results show that using the predicted 2010 carbon emissions factor for grid electricity of 0.520 $kgCO_2$/kWh, a heat pump operating at an efficiency of 250% and above will produce less CO_2 emissions per kWh than an efficient gas boiler. At an efficiency of 500% the heat pump produces less than half the CO_2 emissions per kWh of the gas boiler.

Using the current SAP carbon emissions factor for grid electricity of 0.422 $kgCO_2$/kWh, a heat pump operating at an efficiency above 200% will produce less CO_2

emissions per kWh than an efficient gas boiler. At an efficiency of 500% the heat pump produces well under half the CO_2 emissions per kWh of the gas boiler.

Using the projected 2020 carbon emissions factor for grid electricity of 0.294 $kgCO_2/kWh$, the heat pump produces less than three-quarters of the CO_2 emissions per kWh of the gas boiler when operating at 200% efficiency. At 500% efficiency the heat pump produces less than a third of the CO_2 emissions per kWh of the gas boiler.

It should be stated that the effect of the storage and delivery of heat on the efficiency of the systems has not been considered here.

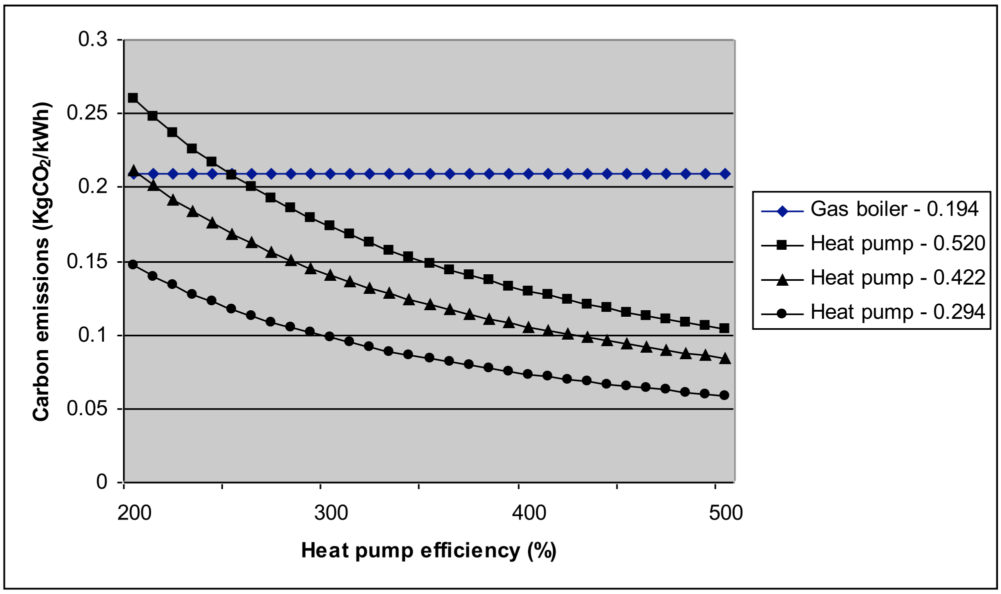


Figure 2. Carbon emissions per kWh of energy produced for a 93% efficient gas boiler and for heat pumps operating at various efficiencies and using various carbon emissions factors for grid electricity ($kgCO_2/kWh$).

The actual efficiency or Coefficient of Performance (CoP) at which a heat pump operates will depend on the system itself, the ambient air or ground temperature, and the output temperature of the hot water being produced. The average efficiency or Seasonal Performance Factor will depend on the amount of output required from the system when operating at different CoPs.

The data in figure 1 shows that a heat pump may produce hot water for space heating with an output temperature of 35°C at an efficiency of 400%, and may produce domestic hot water with an output temperature of 55°C at an efficiency of 300%. This does not take into account variations in ambient temperature but is reasonable for ambient temperatures of 7-10°C. Given these efficiencies, the relative proportions of water supplied at the two temperatures will determine the overall Seasonal Performance Factor. A CoP of between 3 and 4 for a heat pump providing space heating and domestic hot water is consistent with experimental results, as is a rising CoP when the proportion of water produced at the temperature required for space heating increases (Stene, 2005).

Table 6 shows the space heating and hot water demand for three homes: a standard existing home, a standard new home compliant with the 2006 Building regulations, and an advanced home with 'best practice' building fabric. As the thermal performance of the building fabric improves in the homes the space heating requirement is reduced, however, the delivered energy demand for domestic hot water remains unchanged. As is shown, the average efficiency of the heat pump is highest when the proportion of space heating in the total heat demand is highest. This is because the water for space heating is delivered more efficiently due to its lower output temperature. Therefore, the largest percentage carbon savings compared with the gas boiler are made in the standard existing home where the space heating demand is highest.

However, for all the home types and using all carbon emissions factors for grid electricity, considerable carbon emission savings are made in comparison with the efficient gas boiler. These results show that with the predicted carbon intensity of grid electricity in 2010, carbon emissions savings of around 30% can be made by switching from an efficient gas boiler to a heat pump. Clearly, switching from an old, less efficient gas boiler to a heat pump would give even larger carbon savings. Further, if the carbon intensity of grid electricity is reduced through the use of more renewable electricity generation (as projected in the SKM 'medium-renewables' scenario), then by 2020 carbon emission savings of around 60% could be achieved by switching from an efficient gas boiler to a heat pump.

It should be stated that the provision of space heating at 35°C may not be feasible in existing homes since the radiators will be sized for a higher output temperature. In this case, a higher output temperature may be required from the heat pump and this would reduce its Seasonal Performance Factor. An output temperature of 35°C may be possible in existing homes if a new heat distribution system is installed which is sized for the requirements of the heat pump. Alternatively, if improvements are made to the home to reduce its heat loss, then the lower output temperature from the heat pump may be sufficient with the existing heat distribution system to achieve the required space heating.

Table 5. The carbon emissions arising from meeting the space heating and hot water demand, as calculated by SAP, for three 120m^2 detached homes: a standard existing home, a standard new home compliant with the 2006 Building regulations, and an advanced home with 'best practice' building fabric.

Home	Delivered heating demand (kWh)	Delivered hot water demand (kWh)	System and average efficiency	Carbon emissions factor ($kgCO_2$ / kWh)	Total emissions ($kgCO_2$)	Percentage reduction (%)
Standard existing home	12,000	3630	Gas – 93%	0.194	3260	-
			Heat pump – 377%	0.520	2156	34
				0.422	1750	46
				0.294	1219	63
Standard new home	6725	3630	Gas – 93%	0.194	2160	-
			Heat pump – 365%	0.520	1475	32
				0.422	1197	45

				0.294	834	61
Advanced home	1926	3630	Gas – 93%	0.194	1159	-
			Heat pump – 335%	0.520	862	26
				0.422	700	40
				0.294	488	58

Conclusions

The carbon emissions factor of grid electricity is integral in the calculation of carbon emissions from buildings. The current figure used in SAP and SBEM is 0.422 kgCO_2/kWh. This figure was devised as an average for the period 2005-2010. However, using the actual electricity generation figures for 2005 and the updated projections for 2010, the carbon emissions factor was calculated as 0.549 kgCO_2/kWh for 2005 and 0.530 kgCO_2/kWh for 2010. The average of these figures is around 25% higher than the value currently used. This is primarily due to an underestimation of the reliance on coal-fired electricity generation.

The carbon intensity of grid electricity is expected to decrease. Projections made for the Market Transformation Programme (MTP 2008) predict a carbon emissions factor of 0.423 kgCO_2/kWh by 2020. However, the electricity generation energy mix projections used by the MTP study do not include the policy implications resulting from the Renewable Energy Strategy Consultation. These policies will be central to achieving the target for 15% of the UK's energy to come from renewables by 2020. Based on the electricity generation energy mix projected by studies conducted for the Renewable Energy Strategy Consultation (Redpoint 2008; SKM 2008), carbon emissions factors have been predicted here for 2020. The central estimate is for a carbon emissions factor of 0.294 kgCO_2/kWh by 2020.

If the carbon emissions factor of grid electricity does fall as predicted in future years, this has implications when considering the whole-life carbon emissions from a range of building services solutions. Using the carbon emissions factors presented in this study, the current and predicted future carbon emissions from heating using heat pumps were compared with those from an efficient gas boiler. The results show that with the predicted carbon intensity of grid electricity in 2010, carbon emissions savings of around 30% can be made by switching from an efficient gas boiler to a heat pump. With the predicted carbon intensity of grid electricity in 2020, savings of around 60% could be achieved by switching from an efficient gas boiler to a heat pump.

The results presented here show the importance of the carbon emissions factor for grid electricity when making decisions that involve comparing carbon emissions from alternative building services solutions. It is therefore imperative that the most accurate and up-to-date figures are used. Should data on the current electricity generation energy mix or updated projections of the future electricity generation energy mix make the currently used carbon emissions factor unrealistic, then systems should be in place for this to be corrected. Furthermore, accurate and regularly updated long-term projections of the carbon emissions factor for grid electricity should be made available, such that they can inform decisions on issues of whole-life carbon emissions in the built environment and elsewhere.

References

BERR (2008). "UK Renewable Energy Strategy: Consultation." Department of Business, Enterprise and Regulatory Reform.

BERR (2008a). "The Digest of UK Energy Statistics." Department of Business, Enterprise and Regulatory Reform, Table 5.6.

BERR (2008b). "Updated Energy and Carbon Emissions Projections: The Energy White Paper." Department of Business, Enterprise and Regulatory Reform.

BRE (2008). "The Government's Standard Assessment Procedure for Energy Rating of Dwellings - 2005 edition, revision 2." The Building Research Establishment.

DECC (2008). "Updated Energy and Carbon Emissions Projections." Department of Energy and Climate Change, URN 08/1358.

DEFRA (2008). "Climate Change and Energy: Progress towards national and international targets." Department for Environment, Food and Rural Affairs: http://www.defra.gov.uk / environment/climatechange/uk/progress/index.htm [Accessed 08/03/2009].

DEFRA (2008a). "Guidelines to Defra's GHG Conversion Factors - Annexes updated April 2008." The Department for Environment, Food and Rural Affairs.

DTI (2000). "Energy projections for the UK: energy paper 68." Department of Trade and Industry.

DTI (2007). "Meeting the Energy Challenge: A White Paper on Energy." Department of Trade and Industry.

European Commission (2008). "20 20 by 2020: Europe's climate change opportunity." Commission of the European Communities, Brussels.

Great Britain (2008). Climate Change Act 2008 (c. 27). London: The Stationery Office.

MTP (2008). "BNXS01: Carbon Dioxide Emission Factors for UK Energy Use." The Market Transformation Programme: http://www.mtprog.com/spm/download/document/id/759 [Accessed 15/12/2008].

NHBC (2007). "Ground source heat pump systems: Benefits, drivers and barriers in residential developments." The National House Building Council Foundation.

ODPM (2006). "Approved Document L2A: Conservation of fuel and power in new buildings other than dwellings (2006 edition)." Office of the Deputy Prime Minister.

Pout, C. (2005). "CO2 Emission Figures for Policy Analysis." The Building Research Establishment: http://www.bre.co.uk/filelibrary/CO2EmissionFigures2001.pdf [Accessed 15/12/2008].

Redpoint (2008). "Implementation of EU 2020 Renewable Target in the UK Electricity Sector: Renewable Support Schemes." A report for the Department of Business, Enterprise and Regulatory Reform.

Sanyo (2008). "Sanyo Air Conditioners: EU Product Range 2008" Sanyo: http://uk.sanyo.com/AssetBrowser/Air%20Conditioning%20Docs/Brochures/SANYO_EU_Range_2008v2.pdf [Accessed 11/03/2009]

SKM (2008). "Growth Scenarios for UK Renewables Generation and Implications for Future Developments and Operation of Electricity Networks." A report for the Department of Business, Enterprise and Regulatory Reform.

Stene, J (2005). "Residential CO2 heat pump system for combined space heating and hot water heating", International Journal of Refrigeration, volume 28, issue 8, 1259-1265.

Viessmann (2006). "VITOCAL 300 Air/water heat pump 5.4 to 14.6 kW Datasheet." Viessmann product datasheet: http://www.viessmann.co.uk/downloads/Datasheet Vitocal 300-350 AW.pdf [Accessed 11/03/2009].

Enabling low carbon living in UK housing developments

Steffie Broer, Dr Helena Titheridge

University College London, UK

This paper concerns the reduction of greenhouse gas emissions through the design and set up of housing developments in the UK. Current approaches, which are largely based on energy efficiency and renewable energy systems, do not sufficiently contribute to the necessary carbon emission reductions that will be required to meet UK Government targets and to avoid dangerous climate change. A tool (the Climate Challenge Tool) has been developed, which allows house builders to calculate whole life carbon equivalent emissions and costs of various carbon and energy reduction options that can be incorporated into the design of new developments. These cover technical and soft (or lifestyle) measures, covering energy used within the home, energy embodied in the building material, emissions generated through transport, food and waste treatment. The tool has been used to assess the potential for cost effectiveness of various carbon reduction options for a proposed new housing developement in Cambridgeshire. Carbon reduction achievements at the proposed site are then also compared with carbon emissions for a typical UK household. It was found that carbon emission reductions can be achieved at much lower costs through an approach which enables sustanable lifestyles than an approach which purely focusses on reducing the carbon footprint of the energy used in the building through energy efficiency and renewable energy measures. This puts in question current and future policy incentives for new homes such as the 2016 carbon neutral home target which largely focus on reducing and eliminating the emission footprint from the energy used in the homes.

Keywords: Green Infrastructure, assessment tools, carbon footprint, carbon neutral buildings, life-cycle costing, sustainable housing

1 Introduction

Climate change is considered by many to be one of the most important problems facing the world community. This assessment is shared by many organisations, both governmental and non-governmental, including within the UK – the Department for Environment, Food and Rural Affairs (DEFRA 2008) and the Sustainable Development Commission (SDC 2008) and, internationally, the World Economic Forum (WEF 2006). However, there is some uncertainty regarding the precise nature and scale of climatic change and the difference that various levels of greenhouse gas emission reduction will make to the degree of the problem (Stern 2006).

Various climate scientists and political institutions are supporting the "tolerable windows approach" (Hadley Centre 2004; Grass et al 2003; UNFCCC 2004; WBGU 2003). This approach means keeping emissions below a level that could lead to disastrous consequences such as a runaway greenhouse effect, where the climate continues to warm even though no further anthropogenic greenhouse gases are emitted. Current scientific consensus is that a 60 to 80% reduction over 1990 levels of world greenhouse gas emissions is required by 2050 for the developed world, to stand a good change of avoiding "dangerous" climate change, i.e. to remain within the "tolerable window".

In response to this the UK Government has set its CO_2 emission reduction target to 80% by 2050 (Milliband 2008). Intermediate targets of a 20% reduction by 2010 and 30% by 2020 have also been set. These targets are ambitious; it is currently unlikely that the 2010 target will be met, and policies currently planned for the next 10 years are considered insufficient for the 2020 target to be met (AEA Energy and Environment 2008; Dti 2007). UK policy largely focuses on technical solutions such as energy efficiency and renewable energy. For example the Energy White Paper (Dti 2007) includes an analysis of all UK sectors and the likely carbon emission reduction to be achieved in each sector by 2020. The list of measures mentioned is largely based on energy efficiency improvements, more efficient generation and generation from renewable and nuclear sources. The potential contribution from behavioural changes is not mentioned in the document, neither are policies that encourage such behavioural shifts. Unsurprisingly the carbon reductions forecasted in the White Paper for 2020 are insufficient to meet the Government's target.

Within the domestic sector, current Government policy targets carbon emissions reduction through a number of mechanisms. These include providing energy advice through a network of local energy advice centres, subsidising installation of insulation in the home, energy efficient light bulbs and condensing boilers. In new housing developments, the main mechanism for achieving a reduction in the energy used within the home is through part L of the Building Regulations. In the UK every new house is required to meet Part L regulations on energy efficiency. Part L requires builders to meet a certain standard which leads to reduced CO_2 emissions in the use of the building. The standard covers energy used in the home for heating, hot water and lighting.

The Government intends to gradually improve the carbon emissions of new homes, to achieve a 25% reduction in energy used within the home by 2010, a 44% reduction by 2013, with a final leap to 'zero carbon' homes by 2016. The Government has set a goal for all new homes to be 'zero carbon' by 2016. A zero carbon home is defined as a home that produces no net $C0_2$ emissions from energy used by the people living in the home (i.e. to heat and light the home). This, however, does not include energy used in the construction of the dwelling, energy embodied in the construction materials, energy embodied in the goods consumed in the home or transport energy. There are currently no specific national policies that limit, or require an assessment of, carbon emissions from these other ways in which energy consumed by households.

Desai (2004) estimated the contribution of the energy used in a home built to 2002 Building Regulation specification to the overall footprint of a UK resident using a consumer-based accounting methodology. He found that only 11% of the energy used by a typical UK resident living in a new home is used to heat and light the home. This raises the question as to whether there is anything that a house builder can do to encourage emission reduction in the other categories which amount to 89% of emissions UK consumers are responsible for.

Whilst there is significant potential for energy and carbon savings through technological measures such as building insulation, use of high performance glazing, and efficient heating systems (PIU 2002), there is also significant potential for savings through behavioural and lifestyle changes (Oxford University Environmental Change Unit 1997) both within and outside the home. Many of these can be influenced by the design of dwellings and the developments within which they sit. For example, the location of a new housing development (in particular its proximity to services and facilities, including shops and public transport) can influence travel choices and thus the amount of energy used for travel, as can soft measures such as the production of a travel plan (Titheridge 2004). Some of measures can be incorporated into new housing developments through the land use planning system i.e. through transport and environmental assessments, and by applying certain planning conditions. A number of Local Authorities have adopted the so-called Merton Rule; this requires homes in their locality to meet a certain percentage of CO_2 emission reduction from the energy used by the home (typically 10%) by renewable energy sources. Some sites require specific targets under the Code for Sustainable Homes (CSH) to be met. A major aspect of the CSH targets is that Part L regulated emissions need to be reduced by a certain percentage (depending on CSH rating to be achieved) using a combination of energy efficiency and renewable energy measures. However, these mechanisms are not used consistently (see, for example, Hine et al 2000) and not all aspects of lifestyle are covered.

Given that our dwellings last decades, if not hundreds of years, it makes sense to take a more holistic approach than currently being adopted through the building regulations; an approach which allows behavioural and lifestyle factors to be taken into account alongside technological fixes, when assessing options for reducing carbon emissions from new housing developments. In other words – could a wider "lifestyle" approach be more effective at achieving the carbon emissions reductions required to meet the UK Government's targets? In order to make the right choices we need to fully understand three main factors:

- the carbon equivalent emissions implications over the lifetime,
- the implication of behavioural and lifestyle choices made by the residents,
- the cost implications of different measures – so that it can be decided how money is best invested for maximum outcome in terms of minimizing emissions reduction and maximizing the benefits for the residents.

This paper describes an assessment tool (The Climate Challenge Tool) that has been developed as part of research undertaken towards an Engineering Doctorate. The research aims to develop a lifestyle approach to assessing carbon reduction options for housing developments and to examine whether a taking a lifestyle approach could lead to greater levels and more cost effective emissions reduction. Within this paper the tool is described before being used to assess carbon emissions for a typical UK household living in a typical UK dwelling and in a dwelling built to the 2006 Building Regulations. The Climate Challenge Tool is then used to evaluate a variety of different carbon reduction measures for a new housing development in South East England.

2 Carbon emissions assessment tools

Before opting to develop our own tool, we carried out a review of tools currently available to practitioners for calculating energy or carbon emissions. We reviewed the tools based on a number of criteria.

1. Whether the tool calculates the life cycle CO_2e emissions and life cycle costs of different measures and options available to house builders. This information would then enable proposed options to be ranked according the amount of CO_2e saved per £ invested.
2. Whether the tool allows a wide variety of measures to be considered, including measures which promote behavioural change, such as smart metering.
3. Whether the tool would allow the user to compare the carbon footprint of dwelling (or development) being assessed with that of a typical UK household.
4. The scope of the tool, i.e. whether it includes all energy used within the home, energy embodied in the building envelope, energy used in the production of the food and other goods and services used by the household, energy used for transport and for waste disposal.
5. Whether the tool takes into account any wider considerations such as the impact of any measures on the future residents of the buildings and the acceptability of these measures to potential residents.

As can be seen from Table 1, none of the tools we reviewed met all our criteria. The tools tended to only cover the energy used in the home (for space heating, water heating, lighting, and in some instances by other appliances), with some also including the energy embodied in the building envelope. Very few of the tools included costs as well as carbon emissions as an output from the tool. Almost none of the tools allowed direct comparison with a typical UK household, but this could be achieved in most tools by entering data on, for example, the features of a typical UK home, to provide a baseline comparison.

Table 1: The scope of the main tools currently available to house builders for assessing the carbon emissions of their developments

Tool	**1. Outputs include Cost (£)/ tonne of CO_2e saved?**	**2. Technical and behavioural options included?**	**3. Compares savings to the carbon footprint of a typical UK household?**	**4. Includes household energy use, materials, food, waste and transport?**	**5. Impact upon residents assessed?**
Life Cycle Assessment (LCA)	No, life cycle carbon emissions are sometimes included but not costs	Both may be included depending on individual assessment.	No	Yes, can do, depending on boundaries.	Yes
Life cycle Costing (LCC)	Costs are calculated but not life cycle carbon	Behaviour normally not included.	No	Yes, can do depending on boundaries.	No
Ecological footprint	Costs are not included. Life cycle carbon emissions are included but are not usually listed separately	Yes.	For the ecological footprint yes, but not for the carbon footprint.	Yes, but based on national averages.	No
EcoHomes	Costs not included. CO_2 footprint only for household energy.	Technological measures are included. Behavioural measures are touched upon.	No	Food not included.	
The Code for Sustainable Homes	Costs not included. CO_2 footprint only for household energy.	Technological measures are included. Major behavioural measures are not included.	No	Food not included. Major transport issues also not included.	Health and wellbeing covered but only at an aggregate level.
Envest	Cost and life cycle carbon.	Behaviour not included. Limited design choices available.	No	Food, waste and transport not included.	No.
SAP and Energy Certificate	No, CO_2 emission for regulated emissions from direct energy used in home only, estimate of cost implications of energy bills	Behaviour not included.	No, but this could be possible.	Only energy use of building is included	No.
ESTEEM	No, energy and CO_2 only	Some elements of mode choice included, choice of travel destinations included	No, but can compare to a typical household within a region	CO_2 emissions from personal travel generated by new housing developments only	No

We also reviewed a number of tools and developed to model energy and carbon emissions at a district, city or regional scale. These included TEMIS, developed for assessing energy policy at a national scale but since adapted to the city level and applied, within the UK, to Newcastle upon Tyne (1992), the EEP (Energy and Environment Prediction) model (University of Wales at Cardiff 2004), DREAM-city (Dynamic Regional Energy and Emissions Assessment Model)

(Titheridge et al, 1996), TRANUS (Rickaby et al, 1992) and the Quantifiable City model (May et al, 1997). The models are generally limited to the estimation of energy and emissions, although other aspects of resource consumption are sometimes included such as waste and water. Titheridge (2004) developed separate but complimentary tools to DREAM-city that calculate costs, and wider sustainability impacts or the energy and carbon reduction measures being considered. Typically within these models CO_2 emissions are considered on a sector by sector basis, with the main sectors considered being: domestic, commercial, industrial, and transport sectors. Less frequently considered are the relationships between these sectors and how those emissions translate into the carbon impact of the products and services ultimately delivered to UK households.

3 Methodology

A tool (the Climate Challenge Tool) has been developed that will enable developers to compare carbon emission reduction potential for a wide range of measures that can be designed into new housing developments. The measures included in the tool cover both technical solutions such as building integrated renewable energy and soft measures that reduce carbon emissions through encouraging environmentally responsible behavioural changes.

For the tool, we have adopted a consumer-based view. In other words, we have tried to include within the tool emissions generated as a result of a households' lifestyle and behavioural choices, from the energy they use within the home, to the travel they make, the food they buy and the amount and way in which they dispose of waste. Such a consumption-based view has the potential to allow business to target those consumer products and services which have highest overall carbon emissions. Business should then be able to proactively reduce carbon emissions throughout the supply chain in a way that also delivers financial benefits over time. This point of view also means that it is easier to estimate the effect of a decision upon consumer behaviour and therefore permits including both emission savings from technical solutions and from behavioural shifts. Furthermore, policy makers should be able to formulate sensible policies which both take into account the end consumer and the overall carbon emissions implication of their policies.

Within the tool measures are split into five categories. These categories have been chosen to reflect areas which are significant in emissions and can to some extend be influenced by the house builder. These categories are:

1. **Household energy**: the carbon emitted by a home through consumption of energy (electricity and fossil fuels such as gas). A house builder can influence these emissions through energy efficient design and building integrated renewable and low carbon energy sources.

2. **Building materials**: carbon is generated in the production, transport of the building materials, construction on site and disposal at the end of the life of the building. A developer can influence this through choosing locally produced material, building materials that requires little energy to manufacture (e.g. timber), and avoiding or recycling construction waste.

3. **Transport from commuting**: the carbon emitted from cars, and public transport. A house builder can influence this by choosing a site where people can live close to where they work and by provision of low carbon transport solutions (car sharing, public transport), or

carbon free transport provisions (attractive cycling paths and walkways), or by creating jobs locally for example through building offices.

4. **Food**: the embodied carbon in food from, agricultural machinery, transport, packaging material, storage and supermarket energy, can be influenced by the developer by providing allotments to grow food, and market stalls where local produce is sold, promote low carbon/ethical food, or by creating local amenities which offer local and ethical produce.

5. **Waste**: providing recycling and composting facilities reduces waste send to landfill sites where it emits methane, a very strong greenhouse gas. In addition replacing virgin products with recycled products often means a lower carbon footprint in the manufacture of the product. A house builder can influence recycling rates by including good recycling provisions and by raising awareness.

The Climate Challenge Tool allows users to calculate carbon emissions savings and the cost implications of various options available to house builders. The tool is developed in Microsoft Excel and uses a database of emission measures, their potential for carbon savings and cost, to calculate the tonnes of carbon equivalent emissions avoided per £ invested. Capital costs are offset against any monetary savings. These saving were discounted over the lifetime of the measure using net present value (NPV) calculations. In addition to capital costs energy savings and maintenance costs plus replacement costs were taken into account. The NPV was calculated using a 3% discount rate. The tool then ranks the measures being compared on the basis of cost effectiveness, defined as £ per tonne of CO_2 saved. These results can also be displayed graphically.

Available secondary data was used to assess emissions. Where reliable data was not available best estimates were used. Multiple data sources were used to increase the reliability of the estimates. This data came from for example BRE good practice publication, academic literature, government statistics, empirical measured emission reduction achievements from different measures from Bioregional and ESD, Spons and quotations from suppliers. Data from the EPA's WARM Tool was used to assess life cycle emission abatement measures from waste scenarios. In addition a range of relevant stakeholders were sought to gain insight on what emission reduction is likely for different measures that may lead to behavioural changes.

To illustrate the potential of the tool we have first compared carbon emissions for a typical UK household in an average UK home with emissions for a typical UK household in a home build to UK 2006 building regulations for each of the five categories mentioned above. We have then used the tool to examine carbon saving measures for a proposed development on the edge of Cambridge of approximately 2000 houses containing a mixture of houses and flats. Whilst the findings are specific for this site, we expect similar outcomes for other developments in the UK. Changes would result from changes in household size and composition, environmental resource parameters, local transport networks, local amenities and overall size of the development.

A qualitative assessment was conducted for each measure taking into account the capital cost of the measure and its acceptability to residents and developers. On this basis developers can make informed choices on how to deliver carbon emissions reductions. A five point scale was used to indicate which measures are may be most appropriate.

Finally we examined how the same emission reductions as those required by the Government's 2016 zero carbon target for new homes could be achieved through measures applied across all five categories included in our tool.

4 Key findings

4.1 Baseline

Initially the baseline of the emissions in the above mentioned categories was calculated. Including these five categories the emission footprint of the typical UK household is displayed in Figure 1.

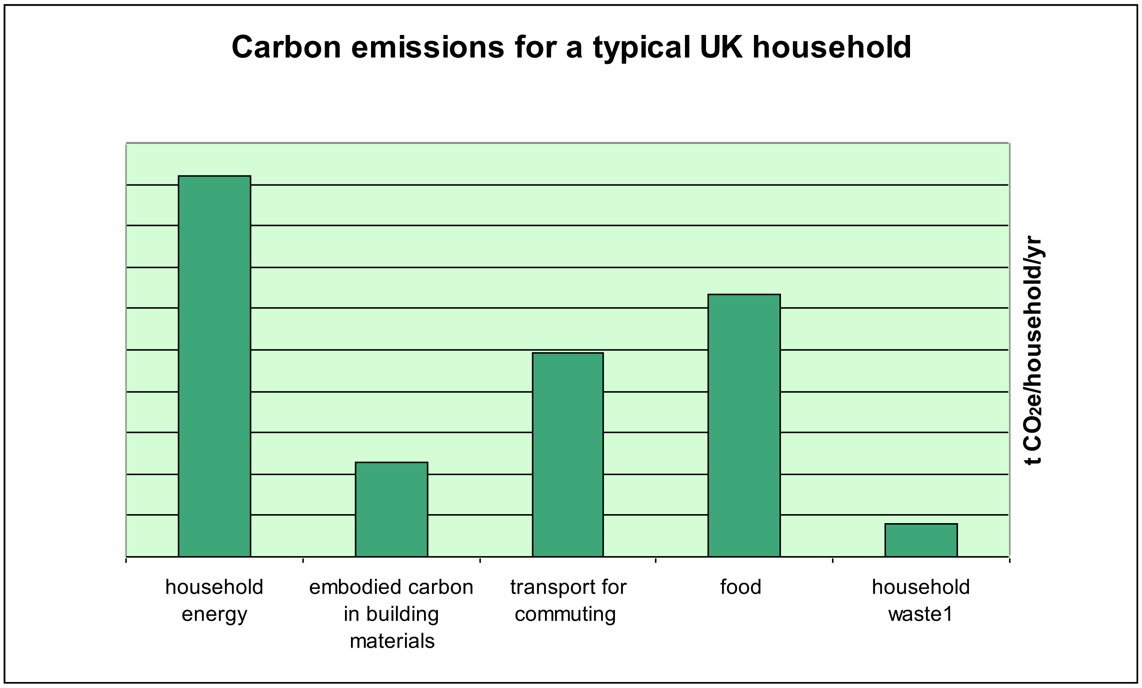


Figure 1: Carbon Emissions for a typical UK household

Under current UK legislation the only categories for which CO_2 emission is regulated and limited is the first category: household energy. As the category with the largest carbon footprint one may rightly argue that it may be sensible to focus policy on the area.

Under Part L of the building regulations every new home is required to achieve a certain energy efficiency standard under the Standard Assessment Procedure SAP. SAP forecasts a likely carbon footprint of the energy used by the home and includes most energy efficiency parameter with a few exceptions such as appliances which are not seen as integral parts of the homes themselves. In 2002 there has been a step change in the energy efficiency standard required under Part L. A home build after this date in the UK would have a household energy carbon footprint which is approximately 40% lower than that of a typical UK home, about 2.9 tonnes of CO_2e/household/yr. Then a new home the carbon footprint of transport from commuting and food is of similar importance as that of the energy used in the home itself.

4.2 Case Study Development

4.2.1 Household Energy

Energy efficiency

A selection of energy efficiency measures were compared for the case study development. Figure 2 orders the energy efficiency measures investigated according to their net present value over tones of CO_2e saved ratio. A number of measures on the left save carbon and have a negative NPV, this is because the value of energy savings is greater than the initial capital outlay even after discounting. Therefore make most sense in terms of both reducing emissions and saving costs. Other measures save carbon at widely varying costs. Recommendations were made both based on this cost-effectiveness criteria and based on a qualitative assessment of the measure. For example, whilst showers with a flow rate of 6 l/s or less both save money and carbon; they were not recommended as they are seen as significant comfort reduction to the residents. Note, not all these measure are included in the UK building regulation's SAP assessment. For example the water reduction measures and A rated appliances are not regulated (Figure 2).

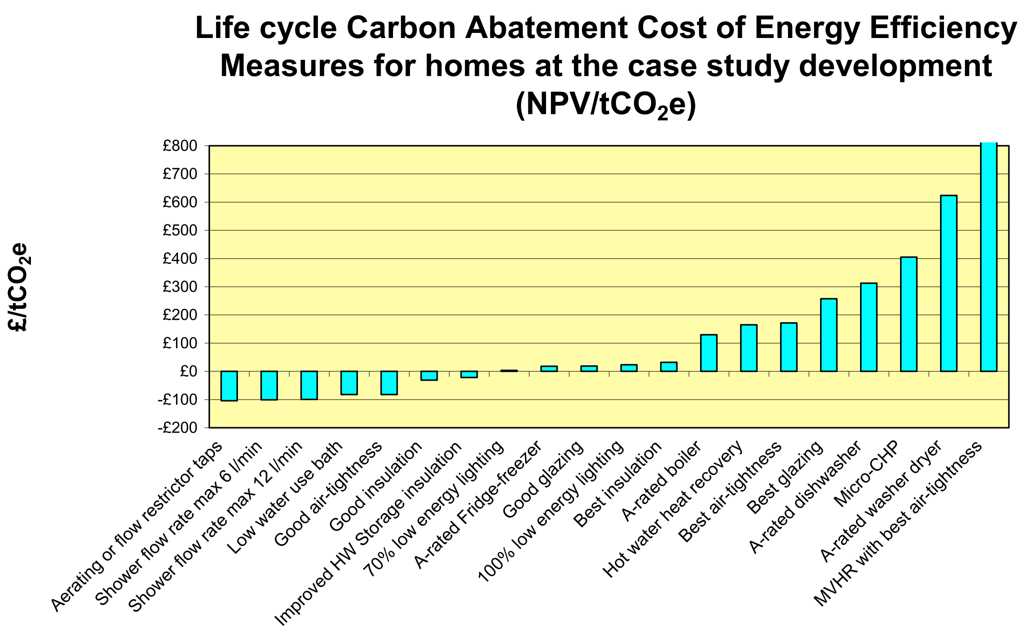


Figure 2 Life cycle carbon abatement costs of energy efficiency measures for homes within the case study development in terms of £ (at NPV) per tonneCO_2e saved

The scoring system used in the Table 2 indicates our judgment of appropriateness of each of the measures considered. This is based on a sliding scale ranging from * indicating unsuitable to ***** indicating highly appropriate.

Table 2: Recommended energy efficiency measures for the case study site

Area	**Measure**	**Descriptions**	**Capital cost estimate per dwelling**	**Recomm-endation**
Hot water saving measures	Aerating flow restrictor tabs	Modern mixer tap which reduces hot water consumption and makes it easier to wash hands	Plus £0 to £20 compared to equivalent mono-taps	*****
	6 l/min flow restrictors for showers	Reduce water flow rate to 6 l/min. This is a compromise in comfort, the flow is too low.	£5- £10	*
	12 l/min flow restrictors for showers	Reduced flow rate to 12 l/min. Flow rates at 10 l/min or above meet comfort levels.	£5- £10	*****
	Low water use bath	Either use small bath, or for taller people use a larger size bath with lowered overflow.	Smaller baths cost less. The Ideal Standard Alto bath can be fitted with low overflow at no extra cost.	****
	Hot water heat recovery	Recovery of heat from shower water via heat exchange coil around drainage pipe. 25% of heat lost in-use and 60% of remaining heat recovered as hot water pre-heat	Approx. £350	****
Appliances	A-rated dishwasher	Low energy appliance saving 300kWh/yr	Approx. £ 75 above typical dishwasher	***
	A-rated washer dryer	Low energy appliance saving 170kWh/yr assuming 3 uses per week.	Approx. £500 above typical washer dryer	*
	A-rated fridge freezer	Low energy appliance saving 35kWh/yr assuming 1 use per day	Approx. £250 above typical fridge freezer	****
Mechanical and electrical services	Improved boiler efficiency	SEDBUK A-rated condensing boiler (92% efficient)	Approx. £200/dwelling	****
	Improved hot water storage insulation	Increased Hot Water Storage insulation thickness (160mm factory applied)	Approx. £100/dwelling	*****
	Micro-CHP	1kWe / 6kWth Micro-CHP unit operating in response to dwelling heat demand in place of boiler	Approx. £500/dwelling	*
	MVHR with 'Best' air-tightness	Whole dwelling Mechanical Ventilation with Heat Recovery system and best air-tightness (3m3/m2/hr) supplying 0.5 ach with 66% heat exchange efficiency	Approx. £1600/dwelling	*.
	'Good' low energy lighting	70% fixed low energy light fittings	Approx. £150/dwelling	****
	'Best' low energy lighting	100% fixed low energy light fittings	Approx. £300/dwelling	****
Building Fabric	'Good' insulation levels	~20% improvement on Part L 2006 standard with wall U-value of 0.2W/m2K, roof U-value of 0.11W/m2K		
	"Best" insulation levels	40% improvement on Part L 2006 standard with wall U-Value of 0.2 W/m2K, roof values of 0.11 W/m2K	Highly dependant on construction detail, typically £100 to £400/dwelling.	****
	"Good" glazing	Double glazed argon filled, overall U-Value of 1.5 W/m2K	Approx. £150/dwelling	****
	"Best" glazing	Triple glazed argon filled, overall U-Value of 1.1 W/m2K	Approx. £400/dwelling	*.
	"Good" air tightness	5 m3/m2/hr at 50 Pa achieved through good detailing and workmanship.	No extra costs.	*****
	"Best" air tightness	3 m3/m2/hr at 50 Pa achieved through good detailing and workmanship, and additional draft specifications.	£200/dwelling.	****

4.2.2 Renewable energy

A similar analysis was conduced for renewable energy solutions. The assessment was based on a target of reducing household carbon emissions by 10% through renewable energy sources.

Figure 3 shows that for the NIAB site the only cost effective renewable energy source is a medium or large scale wind turbine. Other renewable energy sources never pay for themselves. Their costs range from approximately £200 to £700 for each tone of CO2e saved, varying with the different renewable energy technologies. As with the energy efficiency analysis recommendations could then be made both on the £/tCO2e ratio as well as on other practical consideration and additional benefits to residents. Key recommendations would be to employ cost effective energy efficiency measures before renewables, and for this particular site to look into the potential for developing a wind park and hot water contribution from solar energy

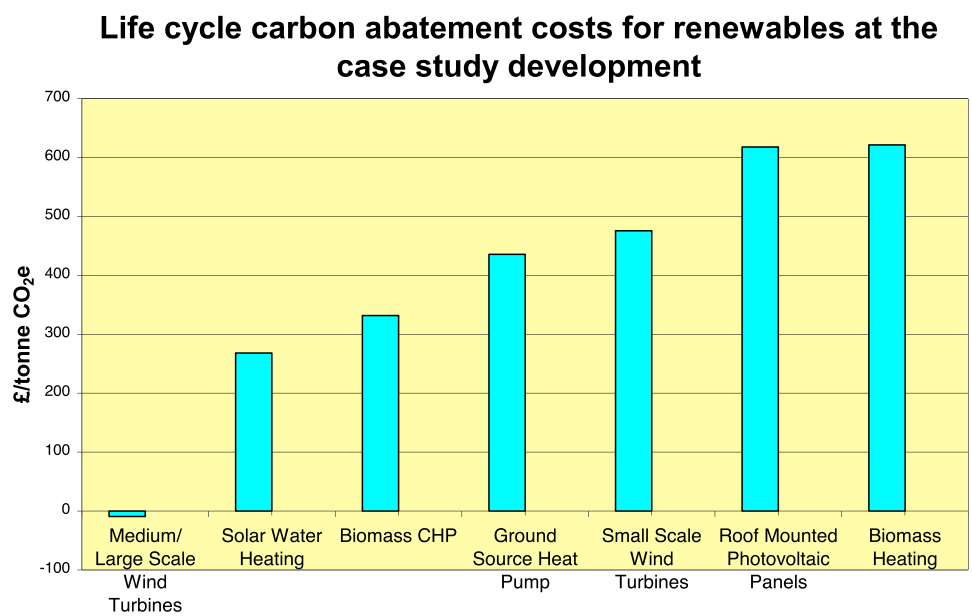


Figure 3 Life cycle carbon abatement costs for renewables options that could be installed at the case study development

4.2.3 Building materials

The same analysis was completed for a choice of options to reduce the carbon emissions embodied in the building materials. Figure 4 displays the CO_2e abatement costs for a number of options to reduce the carbon footprint of the building materials themselves. Cost implications vary significantly. The figure shows that it is important to understand carbon and cost implications and that significant carbon and financial savings can be made when sustainable material choices are made based on this assessment rather than on an ad hoc basis. Using construction waste seems to be the best option; using recycled cellulose insulation instead of rock wool is not cost effective. Using natural carpet is also a far more expensive choice than wooden or tiled floors, but residents may have other reasons for choosing them.

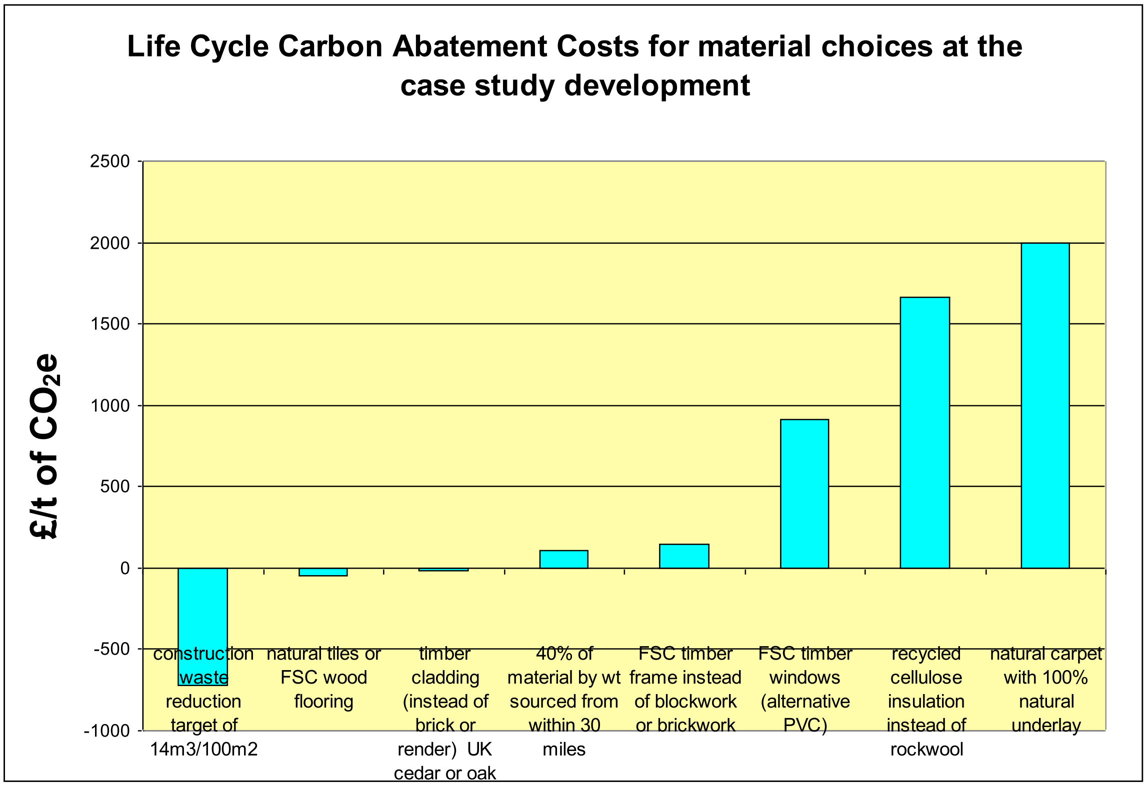


Figure 4 Life cycle carbon abatement costs for building material choices at the case study development

4.2.4 Transport, Food and Waste

The costs and carbon savings involved in making sustainable living easy were then investigated. These included a mixture of measures in the area of transport, consumables and waste.

An example waste scenario for our case study development is shown in Table 3. Our results illustrate that CO_2e emission reduction from intelligent waste treatment can be greater than the direct emissions from waste disposal, i.e. the methane emissions from waste if sent to landfill can be more than compensated for if waste is recycled and thereby offsets the emissions that would have been caused by the use of replaced virgin material. Waste composition was based on UK typical household waste composition and quantified according to the number of household of the proposed development. Note that the waste scenario presented here was selected from a number of scenarios for the greatest CO_2e reduction achievement, and that to maximise carbon savings the best disposal method may be different for different categories of waste. The recycling, composting and incineration rates assumed reflect rates that were deemed achievable with good recycling provisions and awareness raising activity. Note reuse was not an option considered here.

Table 3 Example waste scenario

Material	**Tonnes of waste produced**	**Total CO_2 if sent to landfill (tCO_2 e)**	**Assumed recycling rate**	**Assumed compost-ing rates**	**Assumed combust-ion rate**	**Total CO_2 if sorted (tCO_2e)**	**Waste not sent to landfill (tonnes)**
Aluminum Cans	16.66	0.64	60%			-149	10
Steel Cans	37.49	1.44	60%			-40	22
Glass	197.15	7.58	60%			-30	118
Cardboard and Paper Packaging	111.07	164.86			60%	22	67
Food Scraps	340.16	485.02		40%		264	136
Garden Waste	191.60	-5.58		60%		-25	115
Mixed Paper, Resid.	242.97	298.67	60%			-343	146
Mixed Metals	6.94	0.27	60%			-30	4
Mixed Plastics	112.46	4.32	60%			-100	67
Other MSW	134.67	213.85				214	0
Total	1391.18	1171.07				-217	686
Reduction						119%	51%

Figure 5 displays a number of low cost options to reduce carbon emissions at the exemplary development. Below £100 per tonne of CO_2 are:

- the choice of the right location or mix of uses of the development such as locating homes near jobs or jobs near homes
- the improved access to sustainable local food, through creating allocated commercial space on site or nearby,
- raising awareness on sustainable living (such as home operation, access to sustainable consumables, recycling, sustainable transport options) through employing a sustainable living officer on site.

Comparing Figure 5 to Figures 2, 3 and 4, it becomes clear that there are a number of cost effective carbon reduction solutions in the area of energy efficiency and building material choice. The majority of carbon emission reduction measures however do involve additional costs. The difference in costs per unit of CO_2e saved vary significantly.

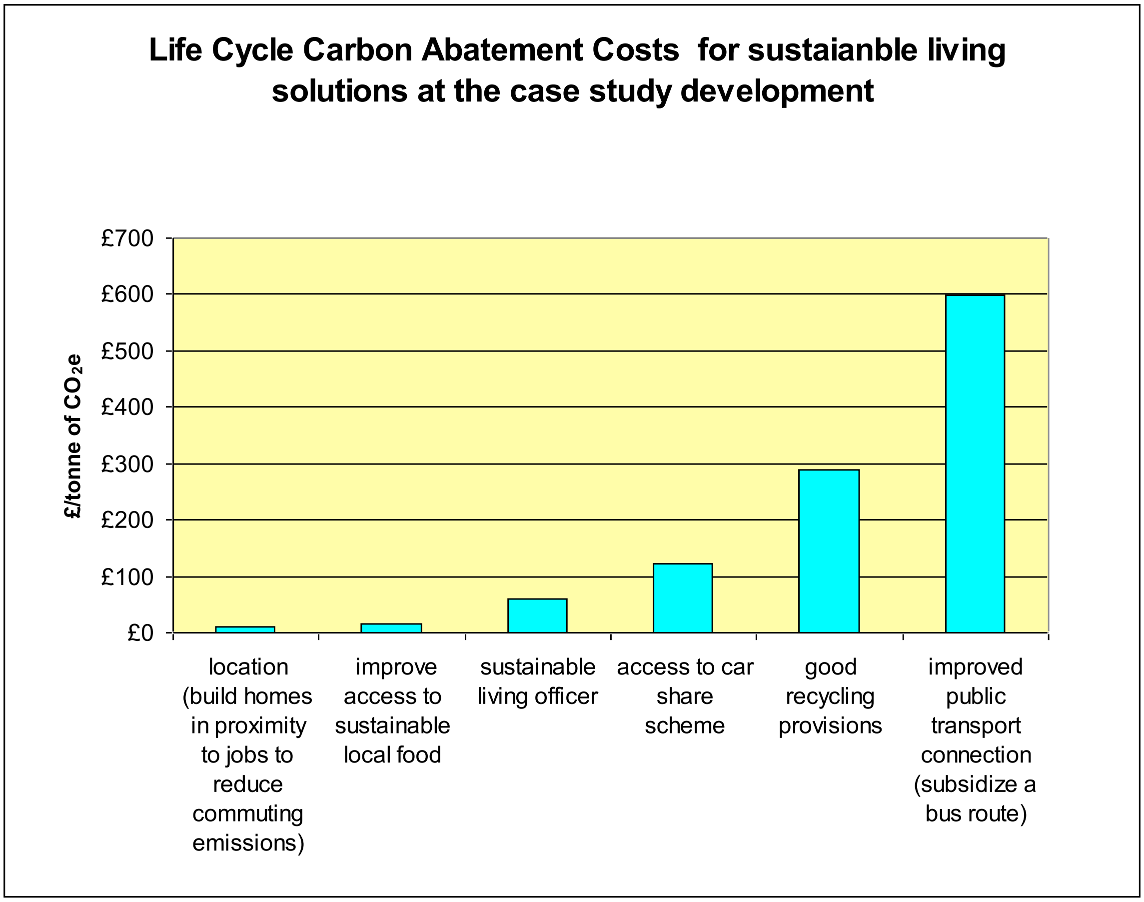


Figure 5 Life cycle abatement costs for sustainable living solutions at the case study development

In most locations the UK Government's proposed carbon emission reductions for 2010, 2013 and 2016 (25%, 44% and 100% reduction of the energy used in the homes) will require to largely use the higher end energy efficiency and renewable energy measures. A few exceptions would be sites located close to suitable sites for wind energy (i.e. near a field with medium to high wind speeds). The costs of the majority of measures employed may lie in the range of £100 and £500 per tonne of CO_2e saved. Indeed for a so called carbon neutral home (as per the Government's 2016 target) the additional capital costs compared to a home that meets building regulations may lie in the order of £20 to £36k.

Our analysis shows that the extra costs of achieving a similar level of CO_2e emission reduction (2.9 tonne of CO_2 per household per yr, based on our baseline analysis) using the lifestyle approach at the exemplary NIAB site would amount to approximately £4k per home. Sensitivity analysis shows that costs would be similar for other housing developments of similar scale and may range between £3k per home and £10k per home. Table 4 shows the chosen scenario for the exemplary development and the emissions savings we assume would be achieved in each category.

Table 4 Estimated CO_2e savings per household at the case study development for measures that go beyond current building regulations

Measures	**Annual CO_2e reduction (tCO_2e/ household/yr**
Low cost energy efficiency measures (air tightness, low e lighting, low flow tabs and showers)	0.3
Solar hot water	0.3
20% increase in waste reduction and recycling through good provisions and awareness raising	0.5
15% carbon emission reduction of food carbon footprint through awareness raising and advice on organic veggie box schemes, once a week local farmers market	0.6
25% reduction in commuting transport emissions though choosing a location with jobs close to the homes, increased cycling, car share scheme and public transport	0.6
Low cost building material with low embodied carbon is chosen (timber frame, timber and tile flooring, timber cladding, site construction waste reduction, minimizing the use of concrete and lead)	0.3
Sustainable living officer achieves 10% uplift in recycling rates, sustainable food uptake, uptake of sustainable transport options and home energy management	0.3
Total	3.1

Figure 6 shows resulting change in household carbon footprint at the proposed development, here compared to a home that meets current building regulations. Please note that carbon footprint of the energy used in the home is significantly lower for a typical new home that a typical existing home (Figure 1).

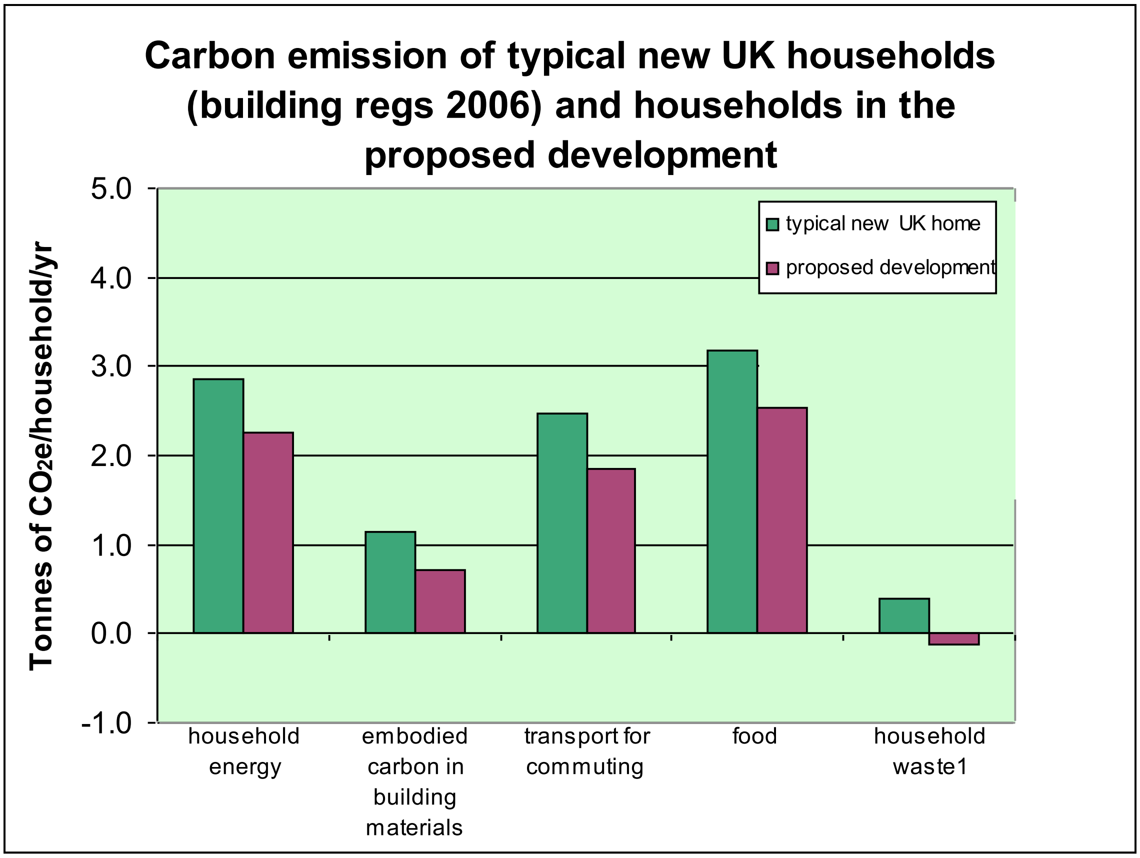


Figure 6 Carbon emissions of typical UK households in homes built to the 2006 building regulations compared with those from households in the case study development

5 Discussion and Conclusions

It has been shown that carbon emission reductions can be achieved at much lower costs through an approach that enables sustainable lifestyles, rather than focusing purely on reducing the emissions of the building in its use. In addition many of the low carbon lifestyle solutions have greater additional benefits to the residents than energy efficiency and renewable energy measures. Good low carbon transport provisions (walking, cycling, public transport, car-share schemes); access to jobs, amenities and low carbon consumables; convenient recycling facilities, and a sustainability officer who supports implementation and community cohesion, may be more valuable to the local residents and the wider local economy, than renewable energy and energy efficiency measures only.

To achieve its challenging climate change targets the government needs to complement their low carbon/ carbon neutral homes aspiration with policies which make low carbon living easy and attractive. In addition there is a missed opportunity to regulate or incentivise emission reduction in the building envelope itself. Transport waste and local amenity policies could

---

[1] Note that for waste the baseline emissions only include emissions once the products have entered the waste stream, whereas for the proposed development the emissions saved from reduced requirements of virgin material, or from fossil fuels in the case of combustion, have been deducted from the waste treatment emissions giving a negative footprint overall.

have a greater focus on reducing CO_2e emissions. The successful emission reduction achieved through building regulations which regulate the maximum likely CO_2 emissions of a building in use, could be replicated in other categories, such as building materials, emissions from commuting, emissions from waste and consumption. This may be a more sensible and costs effective way forward than further regulating the energy used in new homes to be brought down to zero by 2016. Policies should not only target new homes by be inclusive of other policies which effect the above sectors.

The tool can be used by policy maker and developers alike in supporting the design of sustainable low carbon communities. When designing new housing developments it is important to understand the full carbon emission implication of the people living there. This assessment should not be limited to the use if the buildings only but should include a better understanding of the carbon emissions resulting from transport, consumption patterns, waste disposal and building material choices, as well as the effort that is made to raise climate change awareness on site. Only with this holistic understanding will it be possible to achieve the high level of carbon emission reductions the UK government is targeting.

Findings show that many carbon reduction measures, such as building integrated renewable energy, currently required by many local planning authorities, cost far more per tone of carbon saved than other unregulated solutions. Many of the lifestyle option have additional benefits to the residents and may even without additional policy incentives be a viable option for progressive house builders. Future work includes research into gaining a better understanding of customer preferences, wider social and environmental implications of the options. This combined with the tool's outputs on carbon and financial implications may help design more sustainable and climate friendly yet profitable developments.

6 References

AEA Energy and Environment (2008) UK climate change sustainable development indicator: 2006 greenhouse gas emissions, final figures, for DEFRA, UK

DEFRA (2008), Climate Change and Energy, http://www.defra.gov.uk/environment/climatechange/ (accessed 1/12/2008)

DTI (2007) Meeting the Energy Challenge, A White Paper on Energy, May 2007, UK

Grass et al (2003) Climate Protection Strategies for the 21st Century: Kyoto and beyond, Scepcial report, WBGU, Germany.

Hadley Centre (2004), Uncertainty, risk and dangerous climate change - Recent research on climate change science from the Hadley Centre, Met Office, UK.

Hine, J., Rye, T. and M. Hulse (2000) Using Land-use planning to manage a reduction in car-based travel. Transport Policy, 2(1/2), 55-65

IPCC (Intergovernmental Panel for Climate Change) (1999) Chapter 9 Aircraft Emissions: Current Inventories and Future Scenarios. Aviation and the Global Atmosphere. Cambridge, UK: Cambridge University Press.

May, A. D., Mitchell, G., and Kupiszewska, D. (1997) "The development of the Leeds Quantifiable City Model," in Evaluation of the Built Environment, P. Brandon, P. Lombardi, and V. Bentivegna, eds., E and FN Spon, London, pp. 39-52.

Milliband E (2008), cited by BBC in Tougher climate targets unveiled, 16th of October 2008, http://news.bbc.co.uk/1/hi/uk_politics/7673748.stm accessed on 1/12/08

Oxford University Environmental Change Unit (1997) Decade 2MtC. Energy and Environment Programme. Environmental Change Unit, University of Oxford, Oxford.

PIU (2002) The Energy Review. Performance and Innovation Unit, The Cabinet Office, London.

Rickaby, P. A., Steadman, J. B., and Barrett, M. (1992) "Patterns of Land Use in English Towns: Implications for Energy Use and Carbon Dioxide Emissions," in Sustainable Development and Urban Form, 2 edn, M. J. Breheny, ed., Pion, London, pp. 182-196.

SDC (Sustainable Development Commission) (2008), Climate Change – A Global Challenge http://www.sd-commission.org.uk/pages/climatechange.html, (accessed 1/12/2008

Stern N. et al. (2006) The Economics of Climate Change The Stern Review, Cambridge University Press, UK.

Titheridge, H. (2004) Sustainability Assessment of Future Energy Strategies for Milton Keynes. Unpublished PhD Thesis, Faculty of Technology, Open University, Milton Keynes.

Titheridge, H., Boyle, G. and Fleming, P. (1996) "Development and Validation of a Computer Model for Assessing Energy Demand and Supply Patterns in the Urban Environment" Energy and Environment, vol. 7, no. 1, pp. 29-40.

UNFCCC(2004) The United Nations Framework Convention on Climate Change, Article 2.

University of Wales Cardiff (2004) Energy and Environmental Prediction. http://www.cardiff.ac.uk/archi/research/eep/index.html. Last Accessed 20/12/04.

WEF (World Economic Forum), (2006), http://www.weforum.org/site/knowledgenavigator.nsf/Content/_S1531?open&topic_id= (accessed 4/7/2006)

WBGU (The German Advisory Council on Global Change) (2003) Climate Protection Strategies for the 21st Century: Kyoto and Beyond, Special Report, Berlin. http://www.wbgu.de/wbgu_sn2003_engl.pdf (accessed 1/12/2008)

Evaluation of a project for the radical transformation of the Port of Genoa according to Community Impact Evaluation (CIE)

Dr Isabella Lami, Beatrice Beccuti

Politecnico di Torino, Italy

The paper illustrates the evaluation of a project for the radical transformation of the Port of Genoa (an around fivefold increase in traffic; innovative TEU transport system using special shuttles; construction of a dry port around 40 km from that on the sea linked by a tunnel reserved for goods transport in the Apennines) according to the Community Impact Evaluation (CIE).

To evaluate the design alternatives port scenarios, the paper proposes a comparison of two different methodological approaches: on the one hand, that developed by Lichfield (1988) for CIE and, on the other, an experimental type variation to CIE, defined here as 'weighted evaluation approach'. The first approach is based on the hypothesis that the community sector determines the preferential sector only to the extent to which the impact in which the sector is directly involved occurs. According to the second approach, all the impacts deriving from implementation of the project are considered, also according to the importance (assigned according to a percentage weight) attributed by each sector according to its interests.

Keywords: CIE, port

1. Introduction

The project for the transformation of the Port of Genoa developed by Siti[1] in cooperation with a group of Genoa shipping operators, has been developed to Feasibility Study level and is now being examined by the Public Authorities involved.

Obviously, the proposed transformation of what is now the largest non-hub Italian port involves transport-related, environmental, logistic, financial, socio-economic and town planning aspects.

This paper is therefore intended to evaluate the various transformation scenarios of the Port of Genoa developed by Siti through a Community Impact Evaluation - CIE (Lichfield 1988, 1996) with two specific objectives: first of all, establish the expected effects and impacts on the various community sectors affected by the transformation programme and, secondly, define the design alternative most consistent with the goals of the sectors.

According to the steps of the CIE method, the paper identifies the effects and impacts of five aspects considered essential to evaluate the three different design solutions proposed for the Ligurian port, analysing in particular town planning, environmental, socio-economic aspects, impacts on employment and the costs of implementing each design hypotheses.

The paper proposes a comparison of two different methodological approaches: on the one hand, that developed by Lichfield (1988, 1996) for CIE and, on the other, an experimental type variation to CIE, defined here as "weighted evaluation approach". The first approach is based on the hypothesis that the community sector determines the preferential sector only to the extent to which the impact in which the sector is directly involved occurs. According to the second approach, all the impacts deriving from implementation of the project are considered, also according to the importance (assigned according to a percentage weight) attributed by each sector according to its interests. In both cases the CIE models have been developed on the basis of a literature review, a series of informal discussions with various academics and researchers, and some interviews to various experts.

Examining the results of the evaluation, it is possible to reach authoritative conclusions and to comply with the requirements defined at the outset. In particular, it is possible to measure the importance of application of the transformation project as, also for community sectors that could apparently oppose this and which are favourable to the hypothesis of non intervention, the evaluation highlights that the benefits outweigh the costs for these sectors. Lastly, although based on different hypotheses, the two methodological approaches adopted both establish a preference for the same design solution as it generates benefits with regard to socio-economic aspects, with also due attention to environmental issues.

This paper is divided into four sections. The second section illustrates the case study: three project options for the transformation/upgrading of the port of Genoa based on an innovative concept of infrastructure in which the seaport and dry port are linked by a tunnel dedicated to fully automatic TEU rail haulage. The third section illustrates application of a CIE to the case study concerned, adopting two different procedures: the first complying with that proposed by Lichfield, and the second with a modification, introducing a method of weighting that takes into account the impacts on all the community sectors involved. The last section sets forth the conclusions of the paper.

---

[1] SiTI is a non-profit association, set up by Turin Polytechnic and Compagnia di San Paolo in order to produce research and training orientatedtowards innovation and socio-economic growth.

2 Transformation scenarios of the port of Genoa

Compared with North European ports, the port of Genoa offers two major advantages:

- A reduction of 5-7 days of navigation (via Gibraltar) for goods arriving via Suez on the Asia-India-Mediterranean-Europe route;
- Sufficient draught to construct berthing facilities aligned with the new dimensions of ships.

Despite these advantages, there is a risk, in the short-medium term, that Genoa will remain a marginal port of call for major shipping companies, as global carriers tend to concentrate a large swathe of their traffic at terminals that offer first-rate berthing and suitable facilities, large inland stacking areas and frequent, high capacity land transport systems.

Considering the above parameters, SiTI has drafted a number of project proposals for transformation of the port of Genoa.

The context to which these project proposals refer is of great interest both to the Regions involved and to those Far East operators who consider not only the 2000-mile reduction in navigation compared with North European ports, but are also interested in port and interport integration and the technological solutions these intend to adopt. Applying CIE, three project options (plus the "do nothing" option) based on different interpretations of the same innovative idea have been analyzed: the setting up of a suitably-equipped seaport linked via a dedicated railway line to a dry port located in the plain beyond the Apennines. From this point onwards, the goods can be stocked or routed to their destination via rail or motorway (fig. 1 and 2). The aim of the port transformation project is to set up a terminal able to manage transit of 10 million TEUs/year (more than 5 times the present volume).

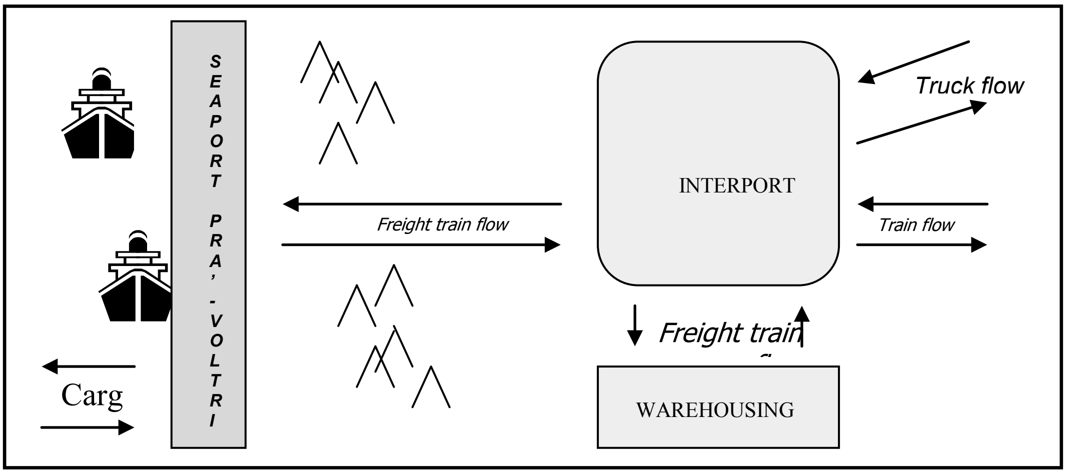


Figure 1 – Functional outline and flow of goods of the new port of Genoa

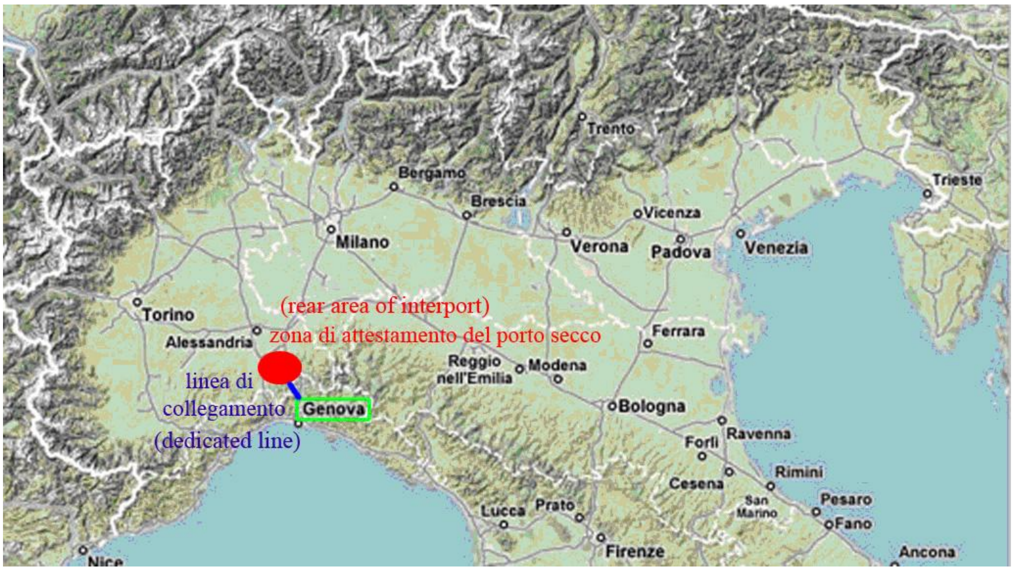


Figure 2 – Location in the territory

2.1 First proposal: re-organisation of berthing facilities and railway link with the dry port[2].

Adopting the first option, berthing capacity would be doubled, preserving the inlet to the West as in the current configuration and constructing two around 2000-m long parallel sections of berth facing each other (one located on the present Voltri quay and the other on the outer breakwater) for concurrent mooring of 10 large ships (Figure 3). The containers are unloaded from the ship onto shuttles that move below the cranes for correct positioning.

The seaport is linked to the dry port beyond the Apennines via an around 20-km tunnel reserved for goods transport in which the TEUs travel on special, fully automatic, diesel and electric powered shuttles. The area of the dry port, located in the Province of Alessandria, has been calculated considering 1m^2 per TEU (the same value as in the current configuration of the port of Genoa) and, according to this index, is equal to 1,000 hectares. A continuous system, a sort of "conveyor belt", is created that guarantees continuous connection between the quayside and the stocking parks beyond the Apennines.

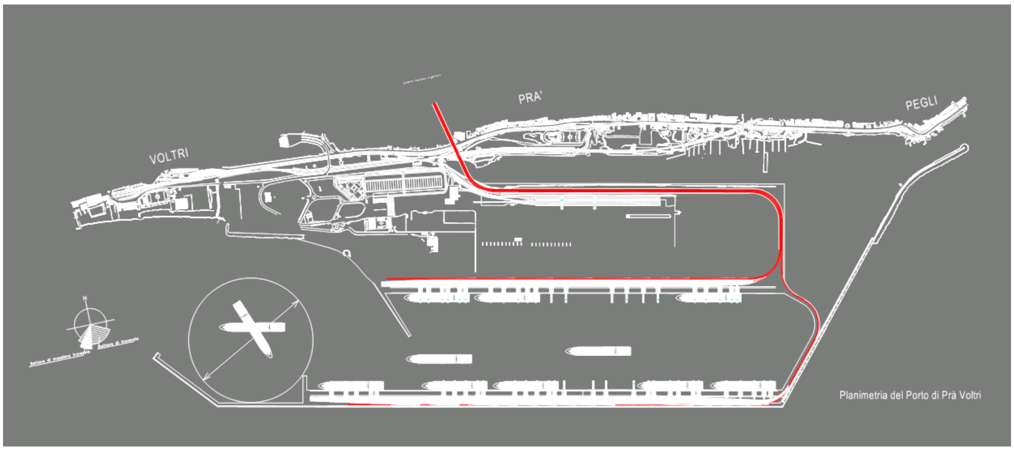


Figure 3 - First hypothesis: the new seaport (Source Lami, 2007)

[2] For a more detailed description of the first hypothesis see I. M. Lami (edited by), 2007, *Genova: il porto oltre l'Appennino*, Celid, Turin.

2.2 Second proposal: project option of the port considered as an "island" and railway link with the dry port.

According to the second scenario, the port is configured as an "island", linked to the connection tunnel between the two ports by a viaduct. This concept has been translated into design terms (Figure 4) through various operations that envisage extension of the channel between the mainland and the new port (1) and continuation of the channel to the West (2) in order to establish an "island" type configuration and to permit transit by small pleasure craft.

The new port is constructed exploiting the possibility of utilizing the space towards the sea, restoring the spaces of the old port to the city of Genoa; this would free the zone of the old waterfront (3) which would be "returned" to the city as areas to be reconverted and where to install new city services. This idea was received enthusiastically by the Public Administration, favorable to exploiting this new urban planning space.

This project option envisages various modifications in relation to the first scenario also as regards the berths, one of which is obtained expanding the breakwater towards the outside (4) while the other is constructed on that already present in the current configuration (5). Further attention is also dedicated to configuration of the railway lines at the port and the automatic ship and shuttle loading/unloading system: while the first option envisages a system consisting of a stable crane and mobile shuttle to position under the crane for unloading of the container, the new system consists of a crane that unloads the container onto a storage platform/buffer close to the crane; a bridge crane then loads the goods onto the shuttle with, in this case, the advantage of not moving. In this case, the shuttles would be electrically powered only. The area of the dry port is reduced by around half (around 500 hectares).

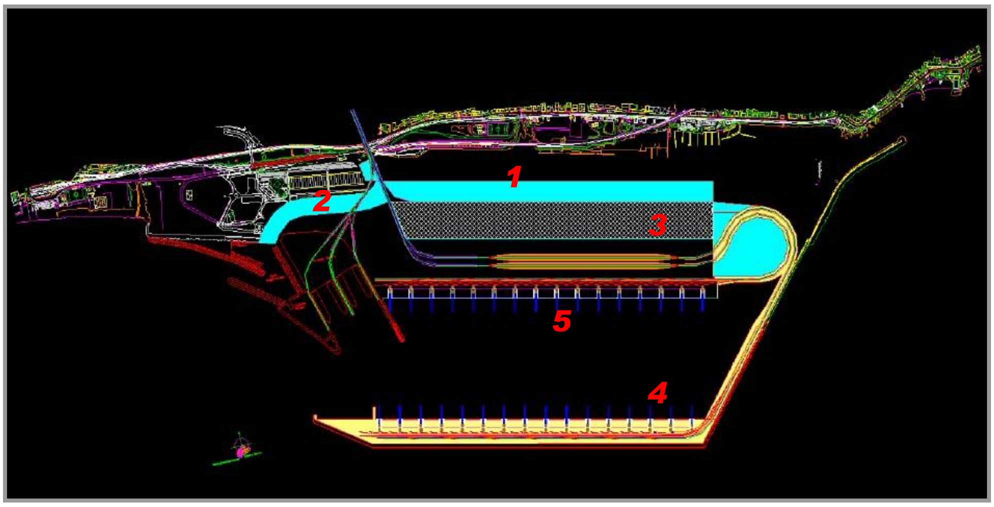


Figure 4 – Second hypothesis: the port as an "island". (Source: SiTI, 2008)

2.3 Third proposal: project option of the port considered as an "island" and underground railway link with the dry port.

The only substantial difference between the third project option (Figure 5) and the previous option is the idea of linking the quayside (still configured as an island and described in the second option) to the tunnel not via an external viaduct but via an underground gallery with a consequent noteworthy mitigation of environmental impact and also eliminating the need to demolish certain buildings, as envisaged by the first option.

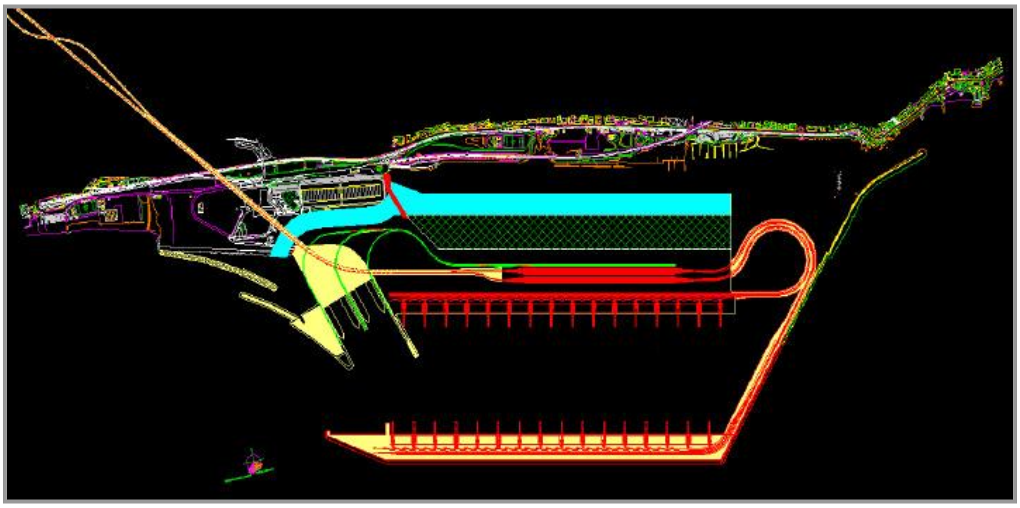


Figure 5 – Third hypothesis: the port as an “island” and underground railway link with the dry port (Source: SiTI, 2008)

3. Application of *Community Impact Evaluation* (CIE) to Port of Genoa transformation scenarios.

To assess the various transformation scenarios of the port of Genoa, Community Impact Evaluation (CIE) has been applied. The CIE is an evolution of the Planning Balance Sheet (PBS), a method of plan evaluation elaborate by Lichfield in the ‘60s. Following earlier hesitation as to whether PBS was best described as “cost-benefit analysis in planning”, which carried with it the disadvantage of association with the form of cost-benefit analysis which had been rejected for planning, PBS emphasized the concern with impacts, and it was “the whole array of impacts on the whole community which are under consideration and not simply particular impacts (economic, social, etc,) on particular sectors, or only those which are measured in money. PBS was accordingly adapted and renamed Community Impact Analysis (CIA), both in order to show that it is more comprehensive than order kinds of impacts analysis (e.g. energy, transport, economic, social,..) and also to show that it is non simply the impact as output which is important (as in impact assessment proper) but the effect of that output on people, i.e. on a community. Furthermore, since the end-purpose of impact analysis in planning is not just assessment but also evaluation as an aid to choice, CIA is seen as a step towards aiding choice in alternatives, ad so become Community Impact Evaluation (CIE)” (Lichfield, 1996).

The CIE has been applied to the transformation proposals of the port of Genoa observing in particular the following aspects (more detailed in table 1):

a) quantitative data TEUs/year handled at the port;

b) urban planning aspects;

c) employment levels;

d) socio-economic aspects;

e) environmental issues;

f) implementation costs of the project option.

3.1 Objectives

The objectives defined at the start of the evaluation are intended to answer four questions regarding economic and planning aspects:

1. What are the overall impacts of the transformation of the Genoa port system and in particular those on employment and the environment?
2. How are the costs and benefits accruing to the sectors considered distributed amongst the stakeholders involved?
3. What are the town planning impacts of each transformation option?
4. Do the project options considered give rise to conflicts between the stakeholders involved? What is the preferred solution for each sector of the community?

3.2 Definition of the data required

The tables below provide data intended to highlight both differences and similarities between the three project options and data that describe the current situation. According to the method, the new project hypotheses must be compared with the *"datum"*, i.e. with *"Option 0"* according to which current conditions are maintained (Lichfield, 1996).

All the data recorded during the evaluation study are shown in table 1.

Table 1– Synthesis of the data of the four proposals

		Option 0 ***(status quo)***	***Proposal one***	***Proposal two***	***Proposal three***
Quantitative data	***Handling TEUs/Year***	1.8 million	10 million	10 million	10 million
Urban planning aspects	***Berths***	2 Total length 2000 m	2 Total length 4450 m	2 Total length 3200 m	2 Total length 3200 m
	Surface of the inland storage area	184 ha	1000 ha	500 ha	500 ha
	Surface restored to the city	0	0	X *(where X>0)*	X *(where X>0)*
	Link between seaport and dry port	0	20 Km	35 Km	35 Km
Employment levels	***creation of "manual" places of employment***	p	<<p	<<p	<<p

	creation of "intellectual" places of employment	q	>>q	>>q	>>q
Socio-economic aspects	***Economic growth of the zone***	s	>>s	>>s	>>s
	New positioning in the shipping market	t	>>t	>>t	>>t
	Economic impulse for the existing activities in the district	v	>>v	>>v	>>v
Environmental aspects	***Air pollution***	x	< x	< x	<< x
	Water pollution	y	> y	> y	> y
	Alteration of the landscape	z	> z	> z	<< z
Implementation costs	***Berths***	-	535 million	Lower Value hyp.1	Lower Value hyp. 1
	Tunnel	-	400 million	Higher Value hyp. 1	Higher Value hyp. 2
	Connection railway line	-	470 million	Higher Value hyp. 1	Higher Value hyp. 1
	Dry port	-	495 million	Lower Value hyp. 1	Lower Value hyp. 1
	Total	-	1.9 billion	-	-
Governance costs		r	r	> r	>> r

Key to table 1: as some of the data indicated are qualitative a representative letter (x, y, z, etc) and the > and < sign (according to whether the result improves or worsens the option 0 – status quo) is used as unit of measurement/index to indicate the hypothetical scope of the impact.

3.3 Evaluation of alternative scenarios

Alternative scenarios for transformation of the port of Genoa have been evaluated adapting the general method to the case study, according to Lichfield: "it is not a standard process, it may differ from project to project"(Lichfield 1996: 104).

Before indicating the results of the evaluation, the following should be noted.

The project is expected to impact two different areas: the urban area of Genoa, with regard to expansion of the seaport, and Lower Piedmont for construction of the dry port. As the consequences will inevitably differ according to nature and "scope", the evaluation has been made distinguishing between the two zones and providing the related tables for each. However, the end result of the final evaluation considers the joint results of both zones.

Here, the term” dry port area” indicates both the zone where the storage park is established and also the connection line with the seaport, whereas the term “Port area of Genoa” includes only the extension of the port.

When making the evaluation, it is necessary to identify and distinguish between “on site” elements and impacts, i.e. in the area bordering closely on that of the project, and “off site” elements and impacts, i.e. areas where the effects of the transformation are propagated and encountered in the territory. In the case study concerned, as there are no substantial differences between the two areas, the “off site” has been considered as englobed in “on site”, establishing the effects and impacts also with broader spillover.

Lastly, the effects are identified only for the operating phase and not for the site construction phase as it is considered that the former will be decisive in selecting the alternative to be adopted.

Application envisages identification of *plan variables* as it is considered that each plan solution generates a change in the existing system and that these modifications depend on a certain number of variables ”(Lichfield 1996: 114). As Lichfield provides very little information, this identification phase is particularly delicate because, in view of the limited information available, the various, decidedly subjective interpretations that may be attributed to the term *“plan variables”* may result in identification of dissimilar variables.

In the application, the following *plan variables* have been considered:

- quantitative data TEUs/year handled at the port;
- urban planning aspects;
- employment levels;
- socio-economic aspects;
- environmental issues;
- implementation costs of the project option.

These variables chart the changes that occur after implementation of the project and start-up of the related activities.

As the aim is to establish the effects of the Port of Genoa project on the various stakeholders involved, the evaluation identifies the various community sectors (tab. 3). Generally speaking, as proposed by Lichfield (1996), these can be divided into two macro-sectors: *producers/operators* (also called active subjects) and *consumers* (or passive subjects). Rather than simply listing the community sectors involved, we have tried to highlight the type of interest of each of these in the project and, therefore, whether they can be classified as *facilitators* or *opponents* of the project. The conclusions reached adopting the Stakeholders Analysis Matrix (Freeman E., et al 2007), reveal that, at the Genoa port estate, the community sectors aim to achieve objectives such as improved efficiency of the zone, improved well-being and upgrading of the berthing capacity of the port whereas, in Lower Piedmont, the aim is to protect the territory or, possibly, to exploit this opportunity to procure mainly economic benefits (as in the case of the farmers who own the land where the dry port will be constructed, which will tend to generate speculative phenomena).

The objectives of the various community sectors are summed up in table 2.

Table 2 – Sectoral objectives

Community sectors	***Objectives***
Producers/operators:	
Local authorities of Genoa	Re-launch of the port economy of Genoa; Economic growth of the area; Increase in employment; Improved welfare and wealth of the population; Competitiveness in the European context; Interconnection with TEN networks.
Local authorities of Alessandria	Economic growth of the area; Increase in employment.
Shippers *Terminalists*	Upgrading of port capacity; Improved offer of services; Higher returns on their activities; Interception of new commercial traffic
Owners of the agricultural areas where the dry port will be constructed	Increase in value of land owned; Requests for any compensation.
Credit Institutes	Good return on their investment.
Production activities of Lower Piedmont	Higher earnings; economic development of the area.
Logistics Operators	Improvement of port logistic conditions; search for TEN interconnections; improved management of the transport cycle.
Consumers:	
Users of the new urban areas of the city of Genoa	Improved urban quality.
Residents of the urban area of Piedmont	Economic growth of the zone; Protection of natural environments; Safeguarding of environmental quality; Protection of own welfare
Residents of zones bordering on the site of the dry port	Economic growth of the zone; Avoid downgrading of present pollution
Environment Protection Associations	Protection of the environment and of the territory (flora and fauna)
Work force of the urban area of Genoa	Increase in employment and/or maintenance of own employment situation.
Work force of the urban area of Piedmont	Increase in employment; Creation of new jobs.
Users of the Genoa road node	Road safety and reduced risks of accidents; Decongestion of road networks.

The evaluation then identifies the effects ("the physical and natural changes resulting, directly or indirectly, from development", Lichfield 1996: 120) and impacts ("consequences or end products of those effect on which we can place on objective or subjective value" […] the consequence of the effects on people which will lead to a change in their way of life, on which the sector's valuation can be based", Lichfield 1996: 124) on community sectors and distribution of these in the project alternatives identified, making it possible to establish whether, in one alternative, the impact occurs more or less in relation to the 0 Option, i.e. doing nothing. Table 3 provides an example of only three items of impact assessment for the dry port.

Table 3 – Examples of impact assessment of project alternatives (dry port area).

Effect on community sector	***Impact on community sector***	***Unit of measurement / index***	***Option 0***	***Hypothesis one***	***Hypothesis two***	***Hypothesis three***
Alteration of the landscape	Loss of the landscape resource	Environmental impact (i)	I	i++	i+	i+
Acoustic disturbance caused by transit of the shuttles between the seaport and dry port	Increase of sound level dB	Sound level (dB) (i)	0	i	i-	i-
Impacts on atmospheric pollution due to transit of heavy vehicles in the zone	Increase in pollutants in the air and production of particulates	Air quality index (i)	i-	i++	i++	i++

Source: personal processing of the "Impact Evaluation of option by plan variables" scheme (Lichfield, 1996).

Key to table 3: as the data indicated are qualitative, a representative letter (i) and the + and - sign (according to whether the result improves or worsens) is used as unit of measurement/index to indicate the hypothetical scope of the impact.

After identifying the impacts, the evaluation determines the preferred option of each community sector affected by the transformation project.

Here, these sectoral preferences have been analysed adopting two different approaches in order to compare the results and to establish the most suitable method for identifying the project option that best complies with the objectives of the community sector.

The first approach, complying with the method developed by Lichfield (1996), establishes sectoral preference considering that the community sector determines its project option only according to the extent to which the impact in which the sector is directly involved occurs. On the contrary, the second approach, applied experimentally to the case study concerned, establishes the preferred project option considering all the impacts generated by the project and according to the importance (established with a percentage weight) attributed by each community sector to each impact according to its specific interests.

We can summarized the first approach corresponding to CIE (Lichfield, 1996) as follow:

1. Framework decision;
2. Effect evaluation and impact evaluation;
3. Decision analysis;
4. Evaluation Report.

The second approach, the "weighted" CIE method, adds two other passages (1.1 and 2.1) to those listed above:

1 Framework decision;

1.1 Attribution of a percentage weight to each consequential impact from the project by each community sector, according to its specific interests;

2 Effect evaluation and impact evaluation;

2.1 Multiplication of the weights for the effect/impact evaluation. When the measurement/index to indicate the hypothetical scope of the impact is qualitative, it is necessary to transpose it on a cardinal scale.

3 Decision analysis;

4 Evaluation report.

The introduction of these two additional passages should allow to consider both, the direct effects / impacts and the indirect, for each community sector.

3.4 Evaluation of sectoral preferences: approach corresponding to CIE

In the first application, the impacts identified occur to a different extent for each option envisaged; the community sector therefore prefers the project option that most effectively meets its objectives and which, at the same time, involves the lowest impact in the case of application of this option.

Therefore, in this case, all the other impacts generated by the project are not considered as it is assumed that each community sector does not attribute any importance to this when selecting its preferred project option.

The above approach has been adopted for each community sector; some items only for consumers in the area of the Port of Genoa have been provided for example purposes in table 4 which illustrates the effects, impacts, the sector involved and the related sectoral objective, the extent to which the impacts occur for each solution and lastly the preference.

Table 4 – Certain consumer sectoral preferences – Port area of Genoa

Effect on the community sector	***Impact on the community sector***	***Community sector concerned***	***Sectoral objectives***	***Unit of measurement/ Index***	***0 Option***	***Proposal one***	***Proposal two***	***Proposal three***	***Sectoral preference*** **
Consumers									
Improvement of air quality due to reduction of heavy vehicle traffic	Reduced production of particulates	Residents of the urban area of Genoa	Improve welfare	Air quality index (i)	i-	i+	i++	i++	(2,3),1,0
Acoustic disturbance created by transit of shuttles	Increase of sound level dB	Residents of the urban area of Genoa	Improve welfare	Sound level (dB) (i)	0	i	i--	i--	(3,0),2,1
Effects on atmospheric pollution caused by transit of the shuttles	Increase of pollutants in the air	Residents of the urban area of Genoa	Improve welfare	Air quality index (i)	0	i	i-	i-	(3,0),2,1
Higher production of waste oils and waste water (ships)	Increased production of waste	Residents of the urban area of Genoa	Improve welfare	Volume of waste produced (i)	i	i++	i++	i++	0,(1,2,3)
Return of new spaces to the city	Opportunities for installing new services and green areas	Residents of the urban area of Genoa	Improve welfare	M^3 restored (i)* **where i>0*	0	0	i	i	(2,3)

Source: personal processing according to ”Impact Evaluation of option by plan variables” scheme (Lichfield, 1996). The project options considered in the same manner are indicated between brackets.

The data obtained for the entire system (port + dry port) are summarized in a more comprehensible, easier to interpret matrix (tab. 5).

Table 5– Summary matrix of sectoral preferences of the community sectors of Genoa

Community sector	Options rating*				Sectoral preferences
	0 Option	Proposal one	Proposal two	Proposal three	
Producers/operators					
Local authorities of Genoa					(1,2,3),0
Shippers Terminalists					(1,2,3),0
Production activities					(1,2,3),0
Credit Institutes					(1,2,3)
Consumers					
Residents of the urban area of Genoa					3,2,1,0
Users of the new urban areas of Genoa					(2,3)
Environment Protection Associations					0,(2,3),1
Manual work force					0,(1,2,3)
Intellectual work force					(1,2,3),0
Users of the Genoa road network					(1,2,3),0
					3,2,1,0

Source: personal processing according to “Summary of sectorial preferences” (Lichfield,1996).

* the levels of preference are colour coded as follows:

- not preferred
- little preferred
- average preferability
- preferred

3.5 Assessment of sectoral preferences: “weighted” CIE method

As already mentioned, the second approach is intended to establish sectoral preference by assigning a weight to the impact generated by implementation of the project.

This step is fairly complex in the case study concerned as most of the information gathered is of a qualitative type and does not therefore lend itself to the necessary reasoning; if numeric data were available, this step would be much simpler and more immediate as numbers are more explanatory.

The evaluation considers that preference for one alternative rather than another depends on the objective the community sector intends to achieve with regard to application of the project: “in planning you cannot please all the people at all the time, so that some must suffer for the grater good, in the public interest” (Lichfield 1996). Therefore, a weight must be assigned that reflects the relative importance of the various types of impacts considered for the social groups; various methods exist for estimating the weights, but Voogd (1983) proposes the *rating* method frequently applied in planning practice. In these methods, the representative of the community sector concerned is asked to rate the impact indicated so that the value assigned reflects its importance (tab. 6).

The underlying idea of this second approach is that the score equal to the percentage impact is assigned to the option that best complies with achievement of the objective. This approach doesn't introduce only a weight, but when the measurement/index to indicate the hypothetical scope of the impact is qualitative, it is also necessary to transpose it on a cardinal scale. Once effected the product between the weights and each impacts / effect evaluation, it is possible to identify the partial numbers which, added together, make it possible to establish the project option that best meets the sectoral objectives. In the evaluation tables (tables 7 and 8 referring only to the zone of the port and to the active community sector) only the *result* is indicated for reasons of simplicity and improved understanding.

Legend table 6:

The weights attributed are expressed hypothetically in percentage terms and indicate how the various sectors are affected differently by an impact. Adding the weights assigned, the value 100% is obtained as it is assumed that if a project option meets all the objectives of a community sector, this option achieves (in table 7) the maximum score (100).

..

Table 6 – Weighting of impacts (Genoa port estate)

	Active community sector					Passive community sector					
	Genoa local authorities	Shippers	Terminalists	Production activities	Credit institutes	Residents of the urban area of Genoa	Users of the new urban areas of Genoa	Environment Protection Associations	Manual work force	Intellectual work force	Users of the Genoa road network
Sectoral objective	Re-launch of the local economy; Increase in employment; Improved welfare; Access to new shipping market	Upgrading of berthing capacity; Improved offer of services	Upgrading of berthing capacity; Improved offer of services	Economic growth of the area; Higher earnings	Good success of the investment	Improved welfare	Improvement of urban spaces; Improved welfare	Safeguarding of the environment and territory	Increase in employment and/or maintenance of own employment	Growth in employment	Road safety; Reduced risks of accidents; Decongestion of road network
Impact	Weights (%)										
Reduced production of particulates	5	0	0	5	0	10	10	15	0	0	15
Increase of sound level dB	5	0	0	5	0	10	10	15	0	0	5
Increase of pollutants in the air	5	0	0	5	0	10	10	15	0	0	5
Increased production of waste	5	0	0	5	0	5	5	15	0	0	5
Increased pollution of port waters	5	0	0	0	0	5	5	15	0	0	5
Economic growth of the zone	20	0	0	20	10	10	10	0	10	10	5
Increased berthing capacity, offer of new mooring services, facilities, increased spaces of the port	10	30	30	0	0	0	0	0	10	20	0
Economic return	10	0	0	0	50	0	0	0	0	0	0
Effects on employment	5	5	5	5	0	10	5	0	50	50	0
Opportunities to develop own business	0	10	10	35	0	0	0	0	0	0	0
Improved fluidity of the Genoa road network	5	0	0	5	0	20	10	5	5	0	50
Opportunity to take advantage of new services	5	0	0	5	0	10	35	0	5	0	10
Handling TEUs/year	10	25	25	10	0	0	0	0	20	20	0
Implementation costs	5	15	15	0	20	5	0	10	0	0	0
Governance costs	5	15	15	0	20	5	0	10	0	0	0

Table 7– Sectoral preferences (port area of Genoa)

	Active community sector																			
	Genoa local authorities				Shippers				Terminalists				Production activities				Credit institutes			
	Option 0	Hyp. one	Hyp. two	Hyp. three	Option 0	Hyp. one	Hyp. two	Hyp. three	Option 0	Hyp. one	Hyp. two	Hyp. three	Option 0	Hyp. one	Hyp. two	Hyp. three	Option 0	Hyp. one	Hyp. two	Hyp. three
Impact	*Score*																			
Reduced production of particulates	0	2,5	5	5	0	0	0	0	0	0	0	0	0	2,5	5	5	0	0	0	0
Increase of sound level dB	0	2,5	2,5	5	0	0	0	0	0	0	0	0	5	2,5	2,5	5	0	0	0	0
Increase of pollutants in the air	5	0	2,5	5	0	0	0	0	0	0	0	0	5	0	2,5	5	0	0	0	0
Increased production of waste	5	0	2,5	2,5	0	0	0	0	0	0	0	0	5	2,5	2,5	2,5	0	0	0	0
Increased pollution of port waters	5	2,5	2,5	2,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Economic growth of the zone	0	20	20	20	0	0	0	0	0	0	0	0	0	20	20	20	0	10	10	10
Increased berthing capacity, offer of new mooring services, facilities, increased spaces of the port	5	10	10	10	10	30	30	30	10	30	30	30	0	0	0	0	0	0	0	0
Economic return	0	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	50
Effects on employment	5	2,5	2,5	2,5	5	2,5	2,5	2,5	5	2,5	2,5	2,5	2,5	5	5	5	0	0	0	0
Opportunities to develop own business	0	0	0	0	0	10	10	10	0	10	10	10	2	35	35	35	0	0	0	0
Improved fluidity of the Genoa road network	0	5	5	5	0	0	0	0	0	0	0	0	0	5	5	5	0	0	0	0
Opportunities to avail new services	0	0	5	5	0	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0
Handling TEUs/year	0	10	10	10	0	25	25	25	0	25	25	25	0	10	10	10	0	0	0	0
Implementation costs	0	5	3,5	2	0	15	10	5	0	15	10	5	0	0	0	0	0	20	10	5
Governance costs	2	2	3,5	5	5	5	10	15	5	5	10	15	0	0	0	0	5	5	10	20
Sectoral Preference	27	72	84,5	89,5	20	87,5	87,5	87,5	20	87,5	87,5	87,5	19,5	82,5	92,5	97,5	5	85	80	85

Table 8 – Summary matrix of sector preferences of the community sectors of Genoa - "Weighted CIE"

Community sector	Options rating*				Sectoral preferences
	0 Option	Sectoral preferences	Hypothesis two	Hypothesis three	
Producers/operators					
Genoa local authorities					3,2,1,0
Shippers					(3,2,1),0
Terminalists					(3,2,1),0
Production activities					3,2,1,0
Credit institutes					(1,3),2,0
Consumers					
Residents of the urban area of Genoa					3,2,1,0
Users of the new urban areas of Genoa					3,2,(1,0)
Environment Protection Associations					0,3,2,1
Manual work force					0,(2,3),1
Intellectual work force					(1,2,3),0
Users of the Genoa road network					(2,3),1,0
					3,(1,2),0

Source: personal processing according to "Summary of sectorial preferences" (Lichfield,1996).

* the levels of preference are colour coded as follows:

- not preferred
- little preferred
- average preferability
- preferred

4. Conclusions

The paper has developed two applications of CIE (one according to Lichfield's method and the other with an experimental variation) to the transformation proposals of a major transport infrastructure with repercussions not only on logistics but also on environmental, town planning and socio-economic aspects.

The results retuned by the two approaches differ slightly with regard to the rating of the solutions according to ambient (table 9), although they both indicate the third as preferred option for the entire system, i.e. that according to which the quayside of the port of Genoa is transformed into an island connected via an underground gallery to the actual tunnel in the Apennines.

This result is also explained thanks to the fact that not only the project's direct costs have been considered, but also the indirect costs. Particularly we have introduced an item of "cost of the governance" of the project, tied up to the additional costs for the extension of the times, caused by the local population oppositions to the realization of the infrastructure. In this sense, the proposal three results preferable to the others, although financially more expensive, because more acceptable for the local population, considering the environmental and urban advantages that it introduces.

Table 9 – Sectoral preferences: a comparison of the results of the two approaches

	First approach: assessment according to CIE	***Second approach: CIE with "weighted assessment" of preferences***
Genoa port area	3,2,1,0	3,(2,1),0
Urban area of Lower Piedmont	(1,2,3),0	(2,3),0
Result	3	3

As Moroni (2006) underlines, Lichfield (1994: 66-7) thinks that CIE is a tool for helping the decision makers to make a choice that is in the public interest in a specific circumstance. CIE is in fact built on the following ideas "planning is carried out for the people; it recognizes that people are not homogeneous but must be seen as sectors with conflicting interests in any project proposal or plan; the sectors cannot all be beneficiaries, since some must lose", planning therefore "aims not at a consensus solution, but at one which does the maximum good or at least harm. That would serve the public interest".

The idea of flanking the traditional CIE method with an experimental assessment approach has permitted more in-depth investigation of the alternatives. In fact, if with the approach complying with CIE, the first project option is to be considered on the same level as the second and third options, this result is overturned with the "weighted" approach. The second approach makes it possible to ascertain that the first project option is certainly the least satisfactory, as preferred only by the community sectors of Lower Piedmont. This result is aligned with the conclusions reached by the Siti research group which has subsequently drafted other project proposals in order to introduce environmental and town planning improvements.

Furthermore, the "weighted CIE" approach confirms that the community sectors of Piedmont also consider the option of not implementing the project (0 option) due to the fear of the environmental spillover generated by construction of the new dry port. In any case, the 0 option is not to be considered a preferable solution: if all the impacts for each single community sector deriving from implementation of the project are considered (second evaluation approach), the analysis highlights that the project has noteworthy beneficial effects on employment levels, an extremely important factor in such a highly depressed zone as Lower Piedmont, to such an extent that the community sectors look favourably on implementation of the territorial transformation project.

Lastly, the two approaches highlight that options two and three are preferred equally by the community sectors of the Genoa port area who obtain advantages in particular at socio-economic and town planning levels (and consequently with regard to welfare of the population). However, according to the more in-depth investigations made with the weighted approach, it can be established that option 3 (compared with option 2) best meets the objectives of both urban areas considered. In fact, while the impacts on employment, socio-economic and town planning aspects of the second option are equal to the third hypothesis, option three is characterised by reduced impacts on the territory. The third project proposal entails more limited impacts on the environment with regard to the Genoa port area (due to construction of the underground railway link) and the zone of Lower Piedmont (as the dimensions of the logistic platform are reduced).

Application of the “weighted CIE” method illustrated here represents a proposed variant to Lichfield’s method, in an attempt to consider all the impacts generated by a project on each community sector; although it requires further testing and tuning, this variant may lay the bases for comparing possible evolutions of the method.

References

Barbanente A. (a cura di), (1989), “Metodi di Valutazione nella pianificazione urbana e territoriale. Teoria e casi studio”, Ragusa Grafica Moderna, Bari.

Bezzi C., (2001) “Il disegno della ricerca valutativa”, Angeli, Milano.

Bezzi C., (1998), “La valutazione. Una mappa concettuale”, in Bezzi C., Palombo M. (a cura di), “Strategie di valutazione. Materiali di lavoro”, Gamma, Perugina.

Freeman E., Rusconi R., Dorigatti M., (2007), “Teoria degli stakeholder”, FrancoAngeli, Milano

Freeman E., (1988), “Strategic Management: A Stakeholder Approach”

Fusco Girard L., Nijkamp P.,(1997), “ La valutazione per lo sviluppo sostenibile della città e del territorio”, Franco Angeli, Milano.

Lami I. M., Donellini E., (2008) “Potential roles of project financing in transforming the port of Genoa”, in 3rd Kuhmo-Nectar Conference - "Transport and Urban Economics"- Proceedings, Amsterdam 3 - 4 July.

Lami I. M. (a cura di), (2007), “Genova: il porto oltre l’Appennino. Ipotesi di sviluppo del nodo portuale”, Celid, Torino.

Lichfield N. (2005), “Towards Social Value for Money”, in Miller D., Patassini D. (eds), Beyond Benefit Cost Analysis, Ashgate, London

Lichfield N., (1998), “Evaluation in planning: facing the chellenge of complexity”, Keuwer Academi Publisher.

Lichfield N., (1996), “Community Impact Evaluation”, UCL Press, London.

Lichfield N., (1989), “ L’approccio costi/benefici alla valutazione dei piani”, in Barbanente A. (a cura di), “Metodi di Valutazione nella pianificazione urbana e territoriale. Teoria e casi studio”, Ragusa Grafica Moderna, Bari.

Lichfield N., (1989), “Uso della valutazione di impatto comunitario nella pianificazione: l’ampliamento dell’aeroporto dell’East Midlands”, in Barbanente A. (a cura di), “Metodi di Valutazione nella pianificazione urbana e territoriale. Teoria e casi studio”, Ragusa Grafica Moderna, Bari.

Lichfield N. (1988), "Economics in urban conservation", Cambridge University Press, Cambridge.

Mambelli T., (2002), “La valutazione dei programmi strategici per lo sviluppo del territorio. Una proposta metodologica “community oriented”, in Lombardi P. (a cura di), “Temi di ricerca nel campo dell’estimo e della valutazione”, Centro Stampa 2P, Firenze.

Moroni S., (2006), “Planning, Evaluation and the Public Interest”, in Alexander E.R. (ed), “Evaluation in planning: Evolutions and Prospects”, Ashgate, London (pp.55-71)

Musso B., 2008, Il porto di Genova. La storia, i privilegi, la politica, Celid, Torino

Siti, (2008), “Genova il porto oltre l’Appennino - Studio di prefattibilità”, mimeo

Voogd H., (1983), “Multicriteria evaluation for urban end regional planning”, Pion, London.

Whole life sustainability of the design of tourist resorts: a coastal alteration prediction model (CAP) using GIS and statistical tools

Assoc. Prof. Ayman Ismail, Assoc. Prof. Husam Bakr

Fayoum University, Egypt

The random and un-substantiated design guidelines of tourist resorts have had its toll on the sustainability of major coastal cities. In many developing countries along the Red Sea, with weak environmental protection institutions, resort owners often dredge lands to increase the usable area of their resorts causing considerable irreversible damage to marine life. Traditionally, the violations have been viewed as policy enforcement issues. However, within a whole life sustainability approach, other factors should be considered. Investors may have economic plot size concerns not considered by planners, tourists may prefer close proximity to deep waters, and urban planners may have failed to realize the importance of certain plot ratios or minimum dimensions and so on. Up till now there has been no metric to relate a plot's geometric properties with the encroachment it makes. If such an association could be made, a developer's resort plans may be evaluated to predict the degree by which an encroachment is likely. Not to argue that an encroachment is inevitable or with a will of its own, but that in the absence of effective environmental regulation enforcement, planners' poor design is literally inviting this devastating attitude. This paper argues that it is possible to identify a number of physical properties of plots that are associated with the long-identified phenomenon of coastal alteration. A combination of GIS and statistical tools are used to identify and model these properties. The model can be used to identify Resorts whose properties present a risk to shorelines, dredge or fill to maximize usable land. Two benefits may be thought of for this approach. First, the model helps urban planners develop a sustainable coastal area by bearing in mind the needs of tourist-developers as well as the properties of their adjacent coast. Second, the factors could be used to rationalize building guidelines and land use regulations to minimize such risk. The research uses data from three different resorts in two countries along the Red Sea coast (Hurghada and Safaga in Egypt and Jeddah in Saudi Arabia). Landsat TM7 images were obtained for each location and ERDAS Imagine â„¢ was used to detect contiguous areas where development seemed to have had the largest alteration along the coast using the post-classification change technique. Physical properties of each village were generated using ArcGIS 9.2 both before and after alteration. Two step cluster analysis and discriminate analysis were performed and it was found that alteration takes place based on the original plot properties in three distinct groups. Finally, a predictive decision-support tool for urban planners and environmental auditors was formulated using stepwise discriminant analysis. The model could classify any given case into one of the three clusters, which can give a rough prediction of the likely alteration that might take place under a given condition.

Keywords: coastal degradation, discriminant analysis, factor analysis, geographical information systems, risk prediction, tourism development, urban planning

1 Introduction

To fully capture the essence of sustainable development, urban decision-makers need comprehensive predictive and prescriptive methods and tools that promote rational decisions about the environment. The tools should recognize economic and social needs and balance them within complex spatial frameworks. Tourist development, especially in coastal zones present one of these challenges.

Along the Red Sea coastline, large recreational cities and centres have been developed, often without any adequate evaluation of potential environmental impacts. The critique of these projects often focused on their adverse impacts which required significant dredge and fill operations, which adversely impact the coastal environment. In addition to the direct destruction of marine life and key habitats, the suspended fine materials resulting from these activities can result in widespread damage to marine life. Such sedimentation results in the suffocation of the benthic communities and has an adverse effect on the surrounding ecosystems (mangroves, seagrass beds and coral reefs) and, as a consequence, a decline in the productivity of the sea. The practice of extending plots onto the coast and into the sea can change the current pattern, morphology and substrate, thus affect the marine life, and usually provide new sources of continuous degradation. (UNEP, 1997)

Change detection and environmental impact have been the focus of many Red Sea studies, covering both the Egyptian and the Saudi sides (see for example Abul-Azm 1999; Khalil, S. 1999; El-Gamily *et al.* 2001, Dewidar, 2002, Al-Rowili *et al.* 2003). Others were concerned with the environmental impact of these changes on ecosystems, coral and marine life. Some focused on integrated coastal management approaches (see Mansour et al. 2007). However, no studies with the exception of Ismail and Khalil (2007) were carried out to analyze these changes from an urban planning and design perspectives. In their paper, they used regression analysis to examine the association between physical factors of tourist projects and the propensity to assault the coast. It concludes that several planning and legislative flaws were likely to have contributed to the encroachment on the coastal strip in Hurghada, Egypt. However, the study was limited to only to single discrete factors as they each related to the decision to encroach. To be truly sustainable, the analyst needs to use a more comprehensive approach that recognises groups of factors. The planner needs to profile Resorts clusters based on their initial properties to be able to determine the likelihood (or risk) of coastal alteration. Furthermore, for the results to be universal, more data from various countries are needed in order to control for institutional and legislative factors.

2 Approach and Data

The Red Sea coastline bounds many countries. Three sites with significant tourist development were chosen, in Egypt Hurghada and Safaga, and on the other side of the sea, Jeddah - Saudi Arabia was selected. These two developing countries share the only significant tourist development experience along the Red Sea. Choosing cities from two different countries allows for neutralizing some external factors that may influence plot design such as regulations and economic factors.

Hurghada is primarily a tourist city of about 110,000 people. It is located 500 km south-east of Cairo on the western coast of the Red Sea. Safaga is a small city of about 34,000 people located 60 km south of Hurghada. Hurghada has an urbanized area of about 110 km^2 and a coastal length of about 38 km. Hurghada was initially developed in 1909 as an oil exploration and later a fishing town. When oil exploration there died down in the seventies, the city's population began to shrink. The opening of the Egyptian economy and the tourist boom of the mid eighties sparked tourist development as a scuba-diving tourist destination. The coastline of Hurghada was quickly transformed into a long coastal-strip development consisting of hundreds of stand-alone tourist Resorts and resorts trapped between the coastal road and the sea. Hurghada attracts more than 25% of the visitors to Egypt, hosting 1.7 million tourists per year. The city was definitely not planned for such a challenge since its city-centre is more of the nuclus-type while the coastal road along which developed has to occur is very close to the shoreline. This has prompted tourist development along a linear spread.

While several laws and building regulations were enacted since 1994, that control setbacks, shorelines and areas, the extent to which these regulatory instruments have been effective is uncertain (Ismail and Khalil, 2007). For one, the laws put the standard as well as the exemption to dodge them. For example, the setback is determined according to the highest high tide water line. Abul-Azm (1999) finds difficulty with the estimation of the highest high water line or the shoreline in a scientific way. Also, the setback limit of 200 meters seems unrealistic when the coastal road maybe less than 50m away. The area limit also makes sea-frontage (which is the most expensive element of tourist real-estate) too narrow. Long after enacting the law, tourist projects continue to violate them, usually land-filling the waters and building more hotel units. (Ismail and Khalil, 2007)

Jeddah on the other side of the sea is a cosmopolitan city of about 2.8 million people. It has a coastal length of about 58 km and total area of about 75,000 km^2. Jeddah's population grows annually by about 6.4%. Its prestige location as Saudi Arabia's second largest city and its main Red sea gateway to Mekka has prompted this rapid growth which was accompanied by an increasingly affluent society (Abdou *et al.* 2002). The search for new coastal tourist recreation facilities lead the city's growth northwards starting about 1990 along a coastal suburb called Obhor. Today, Obhor has about 130 tourist facilities and is believed to house more than 11% of the nation's tourist units. Unfortunately, the pattern with which these facilities were developed calls for a revision of the regulations governing their planning. Plot sizes range from less than 4000 m^2 to about 5 km^2. The coastal bed along these Resorts is rocky and can hardly be used for conventional recreation. Most Resorts have resorted to building piers to reach deep water and many have added land to their Resorts in sizable amounts.

2.1 Data acquisition and preparation:

For each site, at least two Landsat TM7 images were obtained at different dates beginning just before or about when tourist development began and ending in 2008. In the Egyptian coast, tourist development boom began around the mid eighties. In Jeddah, Saudi Arabia, development began about a decade later. The locations and exact dates of the images are shown in Figure 1. ERDAS Imagine ™ was used to detect contiguous areas where development seemed to have had the largest alteration along the coast using the post-classification change technique. Supervised classification was performed using the Maximum Likelihood Classifier (MLC). Then, the detailed maps of the Resorts were obtained and digitized into ArcGIS 9.2 ™.

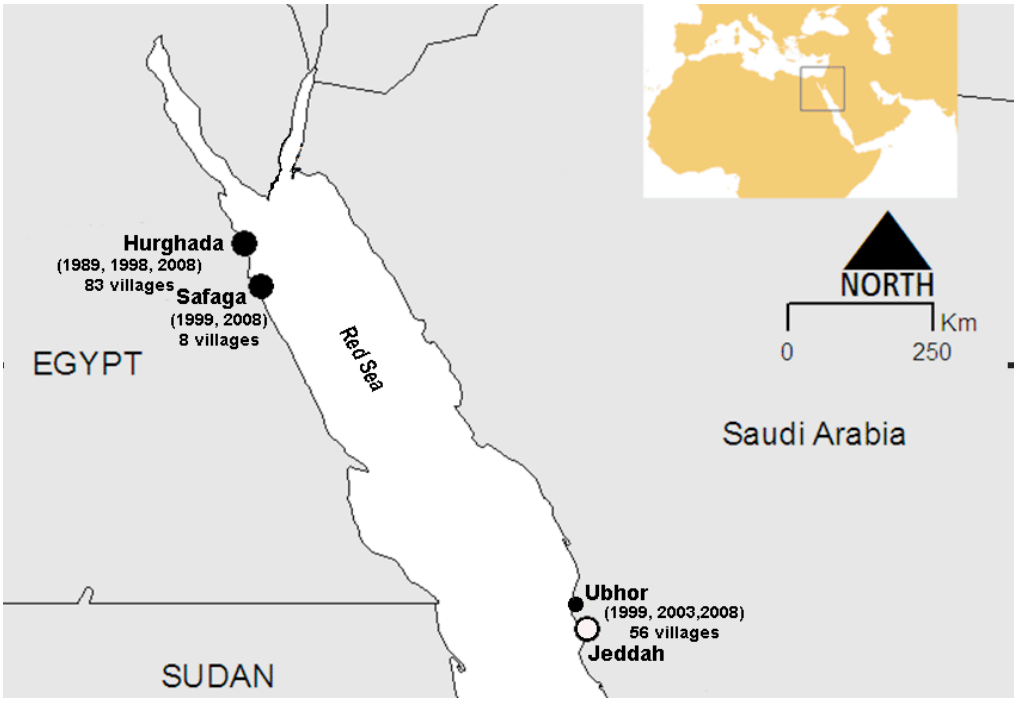


Figure 1: Location Map of the Selected Sites

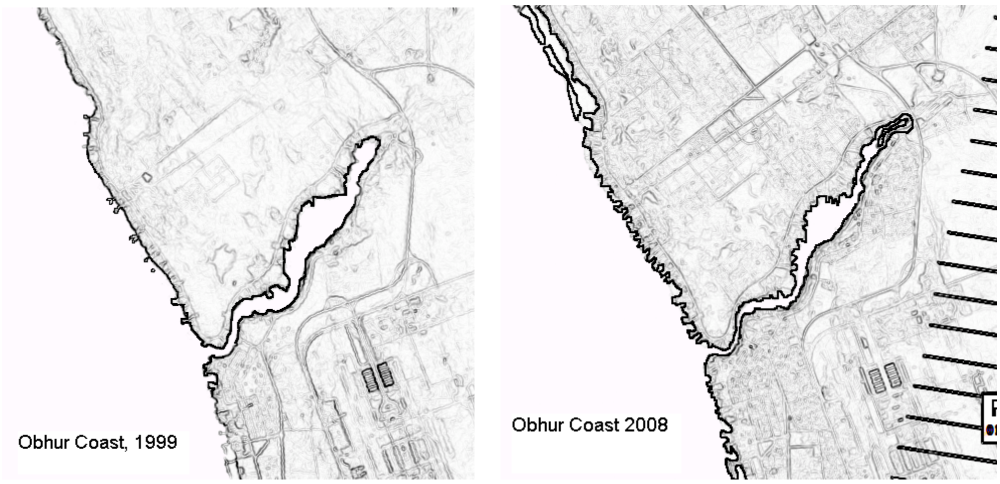


Figure 2 : Coastal Alteration in Obhor, Saudi Arabia between 1999 and 2008

In Hurghada and Safaga the sample had 83 out of 117 resorts. In Jeddah's northern Obhor coast 56 out of 130 resorts were selected. The samples thus represent 71% of the Resorts in Hurghada and Safaga, and 43% of the Resorts in Obhor (95% confidence level).

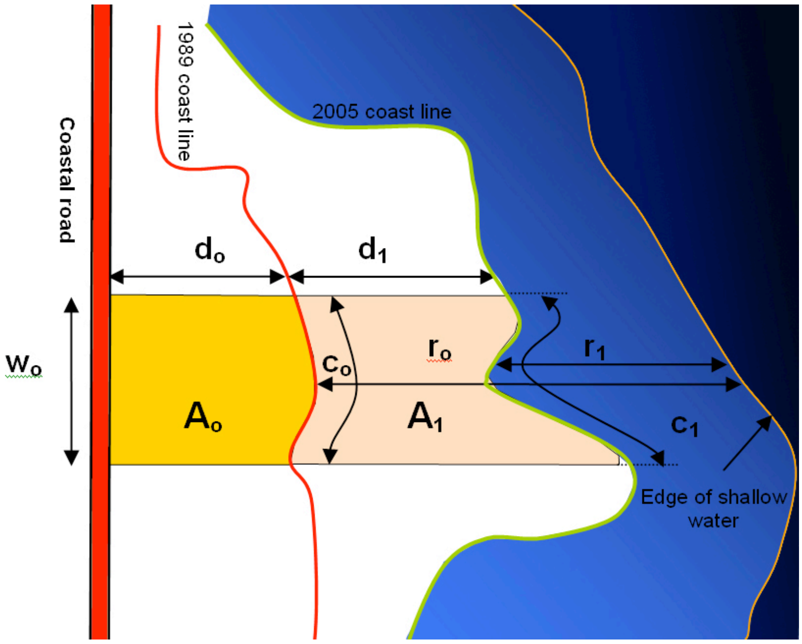


Figure 3 – Computation of the basic objective measures (Ismail, and Khalil, 2007)

2.2 Attribute extraction

Key physical properties of each resort were generated using ArcGIS 9.2 both before and after alteration. These attributes included: original width, depth, perimeter, area, width: depth ratio, shore length, and distance to deep water (figure 3).

2.3 Data analysis

Two step cluster analysis and discriminate analysis were performed. The following is a flow diagram of the model used.

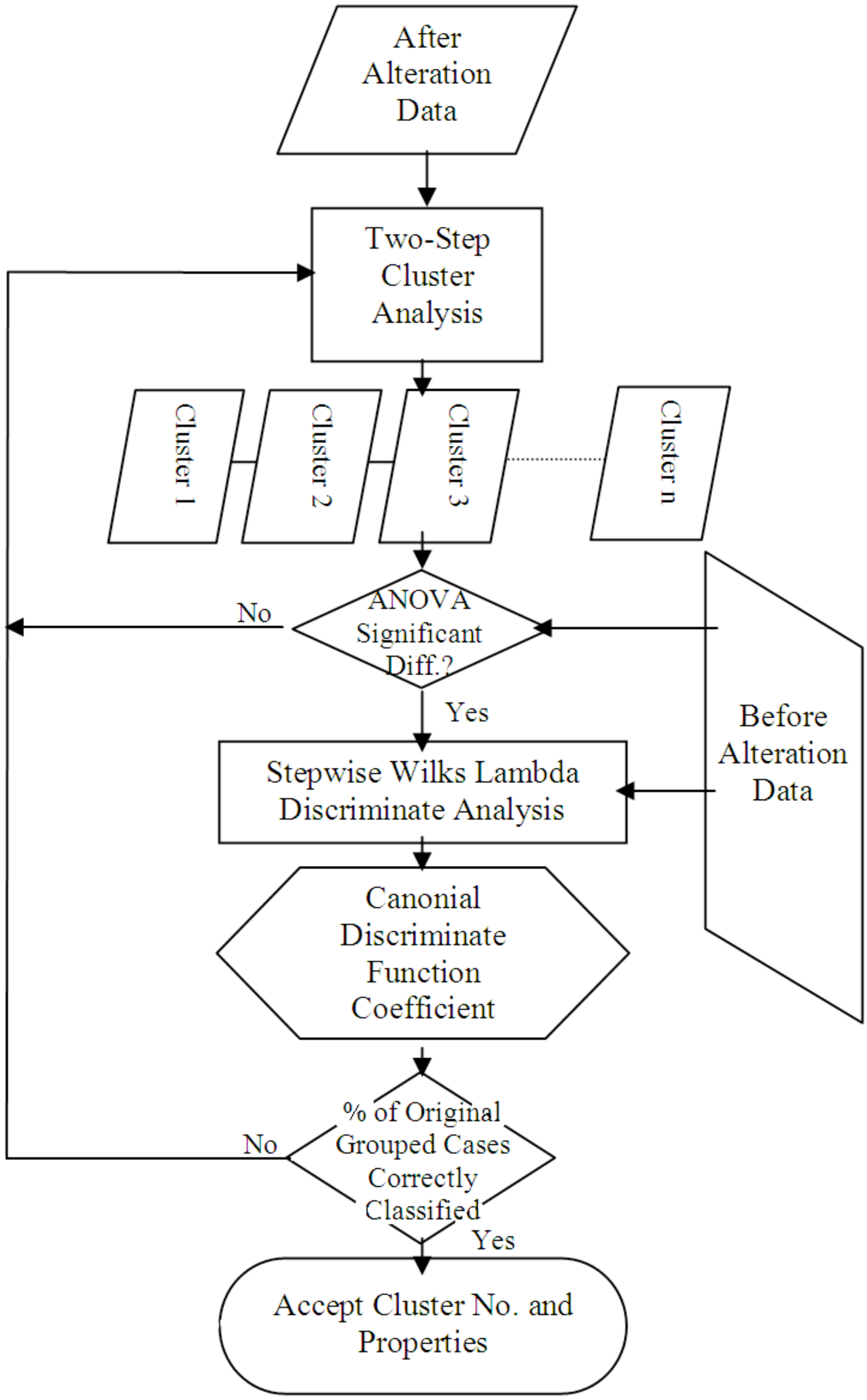


Figure 4 : Flow Diagram of the Statistical Model Used

3 Findings

3.1 Statistical Differences between Egyptian and Saudi Resorts

The following table shows the results of Anova test among the variables. Significant differences (sig. ≤0.05) were found between Egyptian and Saudi Resorts regarding the following variables:

- Original area of Egyptian Resorts is 2.86 times larger than that of Saudi Arabia. New area of Egyptian Resorts is 2.26 times larger than that of Saudi Arabia. Although no significant difference was found as to the added area percentage, area for both countries increased by about 66% a result of alteration (on average).
- Original width for Egyptian Resorts is 2.4 times larger than that of Saudi Arabia.
- Original coast length for Egyptian Resorts is 2.34 times larger than that of Saudi Arabia. Saudi Resorts added 2.1 times more length to its coasts than Egyptian Resorts.
- Original depth / width ratio of Egyptian Resorts is 1.37, versus 2.9 for the Saudi Resorts. After alterations, the ratio rose to 2 for Egyptian Resorts versus 4.7 for Saudi Resorts.
- Original distance to deep water for Saudi Resorts is 1.37 times farther than that of Egyptian Resorts. After alterations, Egyptian Resorts became 3.4 times farther than that of Saudi Resorts. Saudi Resorts added 1.44 times depth more than that of Egyptian Resorts.
- Egyptian Resorts have 1.9 times more swimming pools than that of Saudi Resorts.

Table 1: Statistically Significant Differences between Egyptian and Saudi Resorts

		country		
		Egypt	Saudi	Mean
Original Area **	Mean	39657	13865	29096
	Std. Dev	30570	8916	27261
Original Width **	Mean	182	76	139
	Std. Dev	101	43	97
Original Depth	Mean	206	181	195
	Std. Dev	118	61	100
Original Depth / width **	Mean	1.37	2.93	2.01
	Std. Dev	1.01	1.48	1.44
Original Coast length **	Mean	185	79	142
	Std. Dev	114	54	107
Original Distance to Deep Water **	*Mean*	195	267	225
Added Area	*Mean*	15272	10377	13268
Added Area %	*Mean*	61	73	66
New Area **	*Mean*	54929	24241	42364
Added Depth *	*Mean*	82	118	97
Added depth %	*Mean*	61	73	66
New Depth	*Mean*	288	298	293
No. of Swimming Pools *	*Mean*	1.28	0.67	1.03
New Distance to Deep Water **	*Mean*	99	29	70
New Coast length	*Mean*	462	346	415
Added Coast length % **	*Mean*	168	351	243
New depth / width **	*Mean*	2	4.7	3.1

** Significance < 0.01 level

* Significance < 0.05 level

3.2 Cluster and discriminant analysis

Cluster analysis is a useful tool to determine membership of the samples into an appropriate number of clusters based on modified lot attributes. Several clusters were tested using different combinations of attributes until optimum solution is reached which include the variables area, added area %, width, depth/width, and distance to deep water. Discriminant Analysis is then used to discover whether significant differences as to "before alteration variables" exist among the produced clusters. The "appropriateness" of the cluster formation is determined based on the ability of the discriminant analysis to successfully re-assign sample cases to their original cluster based on formulas developed from "before alteration variables". The following is a discussion of the findings from this method.

3.2.1 Cluster Analysis

After alteration data After 10 iterations, each village was classified into one of three distinct clusters. The first cluster had about 38% of the cases, the second 6%, and the third had about 57% of the cases. The most distinguishing variables within clusters were identified using the Cluster Centroids which is shown in Table 2.

Table 2: Distinguishing variables Within Cluster (Cluster Centroids)

		Cluster			
		1	2	3	Combined
New Area	Mean	72882.88	33638.43	22866.83	42364.24
	Std. Deviation	47491.75	29241.80	15356.17	39889.77
Added Area %	Mean	35.4938	308.3767	62.9822	66.1186
	Std. Deviation	35.90136	191.2285	59.62396	88.59324
Orignal Width	Mean	234.96	78.29	80.35	138.67
	Std. Deviation	90.028	37.986	36.029	97.477
n_depth_by_ width	Mean	1.3936	6.9783	3.8994	3.1220
	Std. Deviation	.73325	6.50849	1.97027	2.59127
New Distance to Deep Water	Mean	79.56	336.03	38.28	70.29
	Std. Deviation	71.541	456.317	45.728	132.455

The table shows the attributes of clusters using "after alterations" attributes that were found significant for the cluster formation. Note that plot width does not change after alteration; hence the naming of the variable 'original' may be deceiving. The variables could be graphed by order of importance for each cluster (Figure 5). The dashed vertical lines mark the critical values for determining the significance of each variable. For a variable to be considered significant, its t statistic must exceed the dashed line in either a positive or negative direction. A negative t statistic indicates that the variable generally takes smaller than average values within this cluster, while a positive t statistic indicates that the variable takes larger than average values. Characteristics of every cluster can be identified from the table and graphs.

For the first cluster, the four variables that contributed to the formation of the cluster were, in order of importance: depth/width ratio, width, added area %, and new area. For the second cluster, the only one variable that contributed to the formation of the cluster was original width. For the third cluster, original width was at the top, followed by new area, distance to deep water, and depth/width ratio.

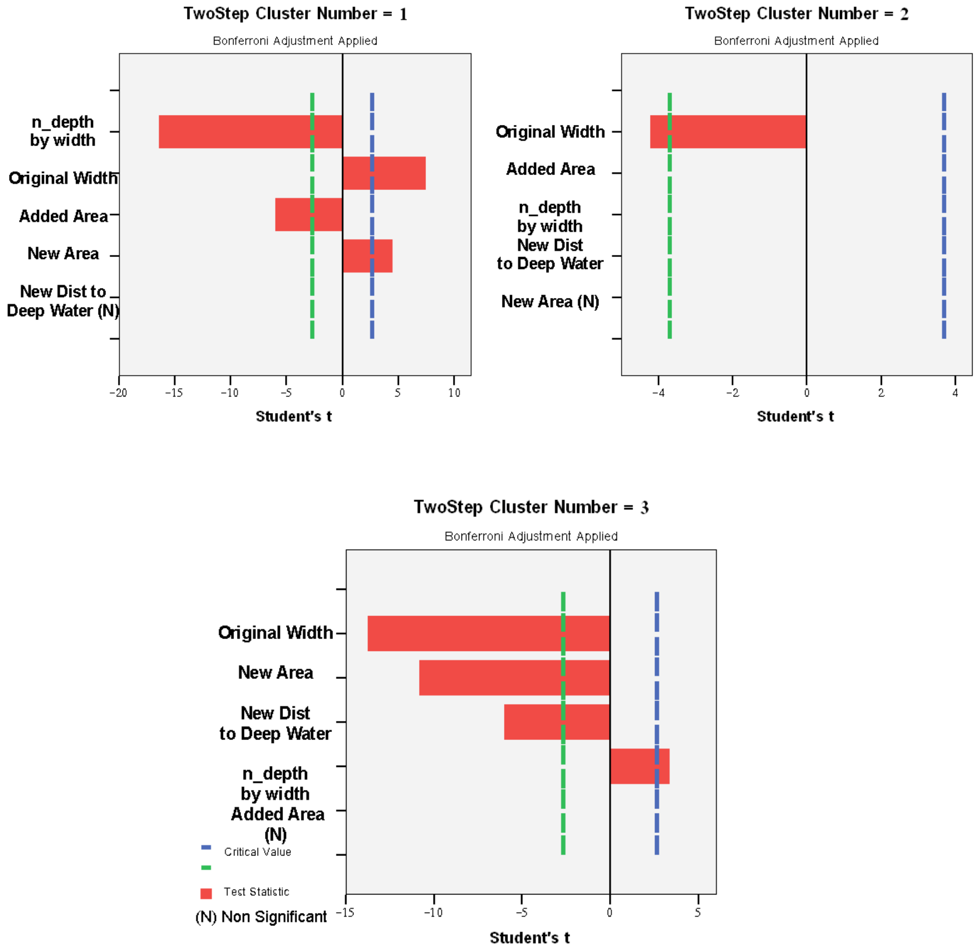


Figure 5: Key variables contributing to the formation of each cluster (in order of importance).

However, the previously identified list of variables does not constitute all the differences between clusters; they are merely variables critical to the formation of clusters. Analysis of variance (ANOVA) was performed to extensively identify differences between clusters using both before and after alterations data. Fortunately, the results indicated significant differences between clusters for all variables except for the number of swimming pools and deep water reach. Table (3) illustrates the differences between means by cluster. This is helpful in identifying a profile of properties for each cluster and serves as a pre-test for the discriminant analysis.

3.2.2 Characteristics of clusters before and after alterations:

Cluster 1: Members of this cluster have the largest original area, width, depth, and original coast length. This cluster has the smallest original distance to deep water and the smallest depth / width ratio, approximating a square.

After alteration, members of this group have the largest new area and absolute added area. Yet, they have the smallest added area %. They also have the smallest added depth, added depth%, depth to width ratio, and added coast length among the clusters.

Cluster 2: Members of this cluster have the smallest original area, width, depth, and original coast length among the clusters. This group is characteristic of the largest original distance to deep water.

Table 3: Mean differences among clusters

Variable	Cluster Number			
	1	2	3	Total
Added Area (sq. m.)	19372	26181	7942	13268
Added Area %	35.49	308.37	62.98	66.11
New Area (sq. m.)	72883	33638	22867	42364
New Perimeter (m.)	1468	1269	975	1177
Added Depth (m.)	75	324	89	97
Added depth %	35.49	308.38	62.98	66.11
New Depth (m.)	303	427	273	293
New Distance to Deep Water	79	336	38	70
New Coast length (m.)	539	523	321	415
Added Coast length %	147	487	284	243
New depth / width	1.4	7.0	3. 9	3.1
Original Area (sq. m.)	53510	7457	14924	29096
Original Width (m.)	235	78	80	139
Original Depth (m.)	228	103	183	196
Original Depth / width	1.06	1.72	2.67	2.01
Original Dist. To Deep Water (m.)	177	615	218	225
Original Coast length (m.)	237	83	84	142

After alteration, members of this cluster have below average new area, and have the largest added area %, and the largest depth/width ratio. They have the smallest width among the clusters.

Cluster 3: members of this cluster have area that is twice that of the second cluster. They have small width, and coast length, similar to that of the second group. They have near average depth, and distance to deep water.

After alteration, members of this cluster have the smallest new area, added area, new depth, new coast length, and new distance to deep water.

Figure 6 summarizes to scale the differences in cluster properties.

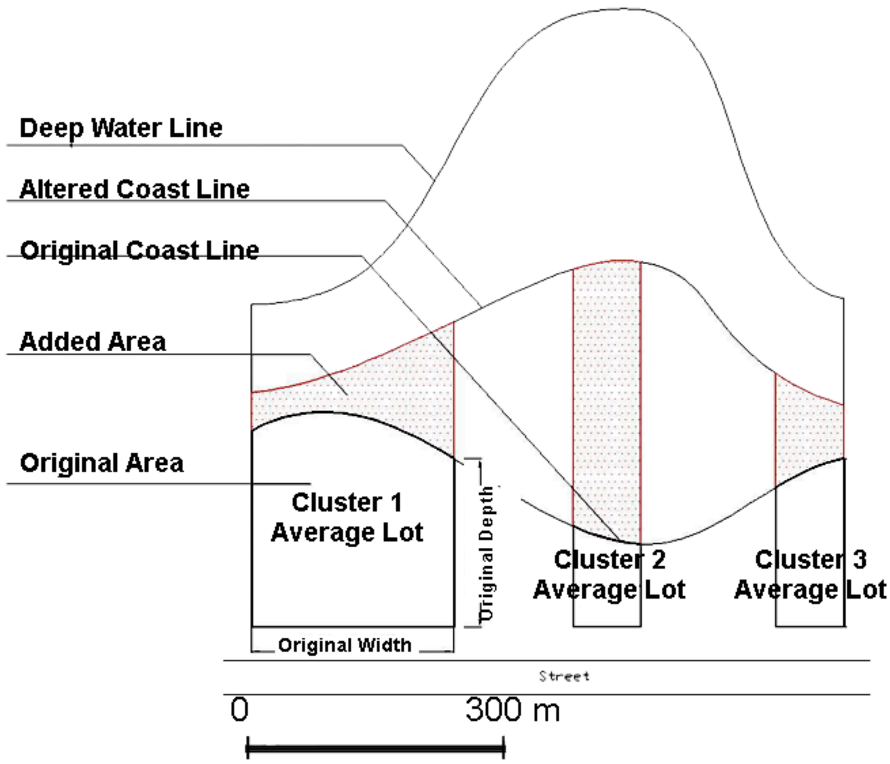


Figure 6: Graphic Summary of Cluster Attributes

3.2.3 Predictive Tool using Discriminant analysis

Finally, to provide a decision-support tool for urban planners and environmental auditors, it would be useful to assign future tourist resort plans to one of the previously formulated clusters, based solely on their original attributes. For that purpose, a model we call Coastal Alteration Prediction model (CAP) was developed using stepwise discriminant analysis (Wilks' lambda method) to find out if cluster membership is associated with distinguishable original lot attributes, and to build a formula that would classify cases into one of the three clusters, which gives a rough prediction of the likely alteration that might take place under a given condition.

The discriminant analysis produced two functions to determine group membership of existing and future cases. The analysis correctly classified about 91% of the total number of cases, which is quite a high percentage. The table indicated that the analysis correctly classified 85% of first cluster, 57% of second cluster, and 99% of third cluster. The discriminant analysis model performed quite well for clusters one and three yet performed average on classifying cases correctly to cluster two. This is acceptable since cluster two has only 5.5 % of the cases. Furthermore, village distribution included both Egypt and Saudi Arabia in the formed clusters, indicating that cluster allocation transcends national conditions.

Discriminate analysis produced an index or linear discriminant functions for group membership. The variables original width and original distance to deep water were the variables selected from "before alteration" variables as predictors of group membership for current and future case membership. High tolerance is indicative of good discriminating ability.

Table 4: Variables in the Analysis

Step		Tolerance	F to Remove	Wilks' Lambda
1	Orignal Width	1.000	92.077	
2	Orignal Width	.991	89.557	.602
	Original Distance to Deep Water	.991	39.511	.402

The canonical discriminant function coefficient table has the perimeter required for producing the classification functions. Two functions are required to identify case location on the territorial map (figure 7), as every case has to have (x) and (y) coordinate to plot correctly. The first function represent (x) component, while the second function represents the (y) component of a case. Functions are:

$$F(1) = -1.19 + (0.15) \times W_o + (-0.004) \times R_o$$

$$F(2) = -2.516 + (0.006) \times W_o + (0.007) \times R_o$$

Where:

W_o Original width, and

R_o Original distance to deep water

The cluster belonging in any given case can be mapped on the territorial map below. The mean for each group is indicated by a square and is called group centroid, the location of which show the strength of separation between clusters, the closer to the territorial lines the weaker the separation. By being able to classify cases into appropriate cluster, we have the ability to roughly predict the likely alteration that might take place based on knowing lot width and original distance to deep water.

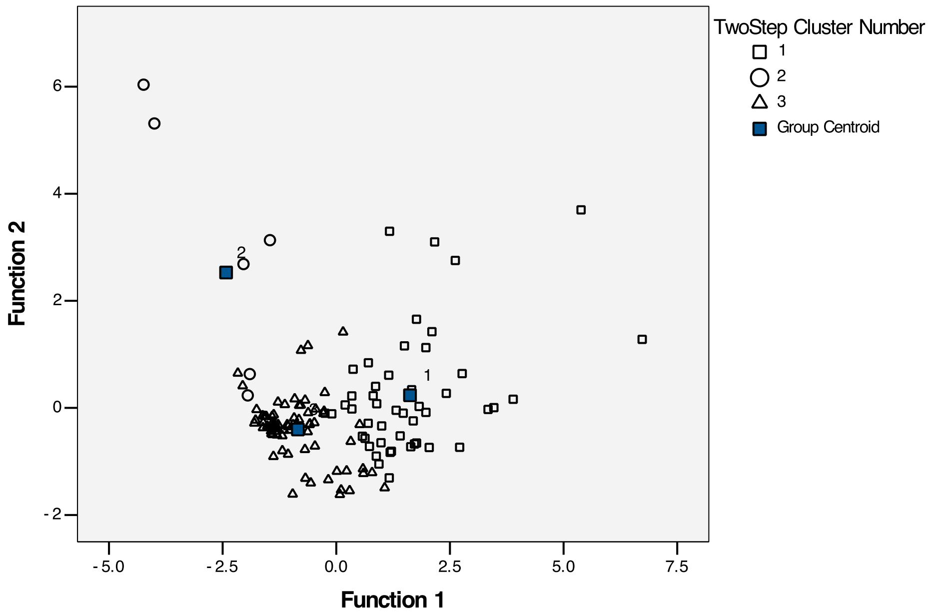


Figure 7: The territorial map of Cluster Belonging

4 Conclusions

Any integrated approach to sustainable development such as the "Whole Life Sustainability" approach should bear in mind that poor planning is a recipe for failure. In the context of many developing countries with weak environmental compliance enforcing capacities places a larger role on the planners. This paper demonstrates - within the context of the two case studies - that it is possible to identify a number of physical properties of plots that were associated with the long-identified phenomenon of coastal alteration. Among the most salient of these properties are original width and original distance to deep water. Any subdivision plan that ignores the power of these two factors literally “invites” owners to violate shore lines and encroach on the sea. Planners are thus urged to join hands with policy makers and developers to formulate guidelines to plot subdivision and environmentally acceptable design solutions to facilitate access to deep water. The developed statistical model can be used to identify resorts whose designs present a risk to shorelines, dredge or fill to maximize usable land. Two benefits may be thought of for this approach. First, the model helps urban planners develop a sustainable coastal area by bearing in mind the needs of tourist-developers as well as the properties of their adjacent coast. Second, the factors could be used to rationalize building guidelines and land use regulations to minimize such risk. The decision-support tool CAP can be used by urban planners and environmental auditors to classify any given case into one of the three clusters, and thus either recommend remedial measures or objectively impose sanctions if dredging has already occurred.

Naturally, altering coastal lines is probably more complicated that just the physical properties of the plot. Among the presumed factors are the beach type, type and size of developer, access to political influence, strength of enforcement and of course corruption. However, the approach paves the way to expand and include as many of these factors as possible. The approach could be further re-enforced by including more coastal cities from both developing and developed countries.

5 References

Abul-Azm A. G. (1999). Tidal Variation in the Red Sea Implications in Law 4/94 in "Land - Ocean Interactions: Managing Coastal Ecosystems "Proceedings of the MEDCOAST '99 - EMECS '99 Joint Conference MEDCOAST 99"

Abdu, M. S. Salagoor, J. Y. Al-Harigi, F. A. (2002). Jeddah Urban Growth And Development Process : The Underlying Factors, Scientific Journal of King Faisal University (Basic and Applied Sciences) Vo.3 No.1 Dhu Al Hajjah 1422 (March 2002)

Al-Rowili, Mohammed S. Fadda, Eyad H. and. Vaughan, Robin A (2003). A comparison of data fusion and unsupervised classification for change detection in Jeddah, Saudi Arabia. In Geoinformation for European-wide Integration, Benes (ed.) Millpress, Rotterdam,

Dewidar, Kh. M. (2002) Landfill detection in Hurghada, North Red Sea, Egypt, using Thematic Mapper images in International Journal of Remote Sensing. Volume 23, Number 5 / March 25, Taylor & Francis

El-Gamily H. I.; Nasr S.; El-Raey M. (2001) ; An assessment of natural and human-induced changes along Hurghada and Ras Abu Soma coastal area, Red Sea, Egypt in International Journal of Remote Sensing . Volume 22, Number 15 Taylor & Francis 2001

Ismail, A (2001) Planning GIS Resource Analysis for Sustainable Development. Procs Computers in Urban Planning Conference, 18-21 July 2001, Hawaii, USA.

Ismail, A and Khalil, H (2007) Planning and Design Factors Associated with Coastal Alteration. Procs National Conference for the Environment – Protection and Pollution, 18-21 March 2007, Qassim, KSA.

Khalil, S. (1999). Ecotourism and Eco-lodge Development on the Egyptian Red Sea Coast in "Land-Ocean Interactions: Managing Coastal Ecosystems "Proceedings of the MEDCOAST '99 - EMECS '99 Joint Conference MEDCOAST 99"

Mansour, Abbas M. Mohamed, Ahmed W. Kamal Eldien, Gemal and Sayed Sayed M. (2007) Sedimentological and Environmental Impacts Of Development Projects Along The Coast Of Hurghada, Red Sea, Egypt 'Egyptian Journal Of Aquatic Research', Vol. 33 No. 1, 2007: 59-84

UNEP/PERSGA (1997): "Assessment of Land-based Sources and Activities Affecting the Marine Environment in the Red Sea and Gulf of Aden". UNEP Regional Seas Reports and Studies No. 166, UNEP, 1997. Available in PDF format on the GPA website.

A fairer place? A prototype framework for assessing the environmental equity implications of proposed urban developments in the UK

Dr Jonathan Walton, Dr Rohinton Emmanuel

Glasgow Caledonian University, UK

There is now international agreement that the current development path of some of humanity is undermining the supporting natural systems required to meet the needs of all of the current generation as well as the likely needs of future generations. The inequity of this is obvious and although sustainable development, the agreed agenda to solve this crisis, is often couched in terms of environmental, social and economic systems in dynamic equilibrium, what is less articulated is that greater equity is a necessary driver for such a condition to be met. At the largest scale, sustainable development has been interpreted as requiring a convergence in living standards around the world to a level representing an overall contraction in the demand placed on the environment, thus having profound implications for the quantities and distribution of natural resources to be used in meeting people's needs. Put another way, meeting the needs of some should not result in others having to live within a degraded environment which reduces their ability to meet their own needs including the protection of their health and well-being: a condition in contrast with that which currently occurs across a number of geographies. Of concern therefore is that although urban decision-makers are increasingly familiar with using sustainability assessment tools to examine how their choices can promote certain environmental, social and economic objectives, the vast majority of such tools give little or no explicit consideration to equity concerns: a situation perhaps unsurprising given the complicated and inherently political nature of such concerns. One notable exception, due to its relative maturity and legal backing, is found in the United States where the Environmental Impact Assessment process can be used to examine the likely distribution of environmental impacts among groups considered already disadvantaged: a process known as environmental justice (or environmental equity) assessment. However, currently in many other countries, including the United Kingdom, no analogous process exists. Accordingly, research was undertaken by SUE-MOT, a consortium of academic, industrial, government and community partners, to develop a prototype framework which would help decision-makers examine the environmental equity implications of proposed urban developments within the United Kingdom. This paper gives a brief introduction to the role of equity in sustainable development (section 1) in order to contextualise a discussion on the concept of environmental equity and generic requirements for its assessment (section 2). The paper then provides an overview of the framework (section 3) which contains three levels of assessment, of increasing complexity, for five key environmental equity issues (the distribution of: noise impacts, air-quality impacts, visual impacts, community severance impacts, and property and community facility impacts). Finally conclusions are drawn (section 4).

Keywords: environmental equity, impact assessment, united kingdom, urban development

1 Introduction: sustainable development and the role of equity

> *"We came to see that a new development path was required, one that sustained human progress not just in a few places for a few years, but for the entire planet into the distant future". Gro Brundtland.*

This observation was made by the Chair of the World Commission on Environment and Development (WCED 1987) in response to a realisation that the current development path of some of humanity is undermining the supporting natural systems required to meet the needs of all of the current generation as well as the likely needs of future generations. It is a succinct insight into the reasoning that led to the now commonly articulated definition of sustainable development, the proposed solution, first championed at that seminal event:

> *"development that meets the needs of current generations without compromising the ability of future generations to meet their needs".*

Thus at the heart of sustainable development is a concern for greater equity between those alive today (i.e. "intra-generational equity") and between current and future generations (i.e. "inter-generational equity") in terms of their ability to meet their needs (United Nations 1992; United Nations 2002; UK Government 2005; Dobson 1999). Accordingly, a key concern in the promotion of sustainable development is the nature, quantity and distribution of resources required to provide this ability (Daly and Cobb 1989; Pearce and Barbier 2000; Wackernagel and Rees 1996) with a number of interpretations of equity informing efforts to address this concern. Notable among these are utilitarianism and Rawls's theory of "Justice as Fairness" (Rawls 1971).

Utilitarianism holds that an equitable society is one which promotes the maximum good for the maximum number of people (Honer and Hunt 1978). This interpretation of equity is reflected in the concept of "weak sustainability" which holds that man-made and natural capital are ultimately substitutable (suggesting future generations can ultimately be compensated for the loss of any and all natural capital through adequate returns in man-made capital) and thus sustainable development occurs when the sum of the stocks of these capitals increases into the future (Pearce and Atkinson 1993; Neumayer 2003). Accordingly, in line with utilitarianism, weak sustainability seeks to maximise the total good within and across generations and requires the current generation to make resource allocation decisions to that end (Markandya and Pearce 1988; Rabl 1996) and thus not necessarily requiring the protection of natural capital.

One major criticism of utilitarianism is that it does not recognise the "separateness of persons" (Rawls 1971) leading *in extremis* to perverse consequences including a perceived justification for slavery due to the benefit it delivers to a slave-owning majority. Responding to such failings (in utilitarianism and other interpretations of equity such as libertarianism) Rawls's theory of "Justice as Fairness" sought to reconcile liberty and equality in a principled way (Rawls 1971). The theory argues that if each person were in "the original position" of being asked to identify the principles for an equitable society (which would then be established) but were asked to do so when they were under a "veil of ignorance" as to their own abilities and interests (and thus as to their likely resulting standing in the new society) two such principles would necessarily follow: The "Equal Liberty Principle" (each person is to have the maximum liberties compatible with the same liberty for all) and the "Difference Principle" (inequalities are permissible only if (a) they can be expected to work to everyone's advantage, especially to the advantage of the least well off and (b) the positions, offices, roles, to which the inequalities are attached are open to all under conditions of fair equality of opportunity). These principles led Rawls to argue that an equitable society is indeed organised to maximise individual liberty but not at the expense of the satisfaction of certain "minimal rights" necessary for equality of opportunity (such as the right to education, economic opportunity and to a basic level of consumption).

This Rawlsian interpretation of equity is reflected in the concept of "strong sustainability" where the notion of minimal rights has been extended to include rights in relation to environmental quality such the right to clean air and water, the right to a stable climate or the right to live in a bio-diverse world (note, this latter right represents an important interface between anthropocentric rights in relation to the environment and the idea of intrinsic rights of non-human species) (Costanza 1994; Neumayer 2003). Put another way, strong sustainability holds that natural and man-made capital are ultimately not substitutable and seeks to respond to uncertainty both over the future behaviour of complex natural systems in response to current pressures (Muradian 2001) and over the likely needs of future generations (Rabl 1996) by interpreting sustainable development to require that each generation is free to meet its own needs as it sees fit as long as it does so in ways that do not reduce stocks of natural capital to the point at which they cannot regenerate. This "living on nature's interest" interpretation underpins arguably the second most common definition of sustainable development (IUCN-UNEP-WWF 1991):

> *"improving the quality of human life while living within the carrying capacity of supporting ecosystems".*

Thus the strong interpretation of sustainable development demands that meeting the needs of some of those alive today should not result in others (alive today and in the future) having to live within a degraded environment which reduces their ability to meet their own needs including the protection of their health and well-being: a condition in contrast with that which currently occurs across a number of geographies.

Globally, the vast asymmetry between those benefiting most from carbon intensive economies and those who now and in the future will be burdened with the worst impacts of the resulting climate change represents a stark example of our current unsustainability (Global Commons Institute 2009). This inequity of benefits and burdens mediated through the environment (i.e. this lack of "environmental equity") has also been recognised across smaller scales for example in regard to those who will benefit most economically from new roads or factories differing from those who will be burdened with the resulting reduction in air quality or elevation in noise levels (Faber 1999; Agyeman and Evans 2004)

Yet despite the importance of greater environmental equity to realising sustainable development and although urban decision-makers (responsible for a particular form of man-made capital which greatly influences sustainable development and the equity of society (Haughton 1999)) are increasingly familiar with using sustainability assessment tools, it is concerning that the vast majority of such tools give little or no explicit consideration to environmental equity issues (Walton *et al* 2005): a situation perhaps unsurprising given their complicated and inherently political nature. One notable exception, due to its relative maturity and legal backing, is found in the United States where the Environmental Impact Assessment process can be used to examine the likely distribution of environmental impacts among groups considered already disadvantaged: a process known as environmental justice (or environmental equity) assessment (USEPA 1998; CEQ 1997).

However, currently in many other countries, including the United Kingdom, no analogous process exists. Accordingly, research was undertaken by SUE-MOT, a consortium of academic, industrial, government and community partners, to develop a prototype framework which would help decision-makers examine the environmental equity implications of proposed urban developments within the United Kingdom. Contextualised by the discussion above, this paper now examines the concept of environmental equity as well as generic requirements for its assessment (section 2). It then provides an overview of the framework (section 3) which contains three levels of assessment, of increasing complexity, for five key environmental equity issues (the distribution of: noise impacts, air-quality impacts, visual impacts, community severance impacts, and property and community facility impacts). Finally conclusions are drawn (section 4).

2 Environmental equity: concepts and generic assessment requirements

Although the application of equity in relation to environmental concerns is not new (for example in regard to land rights) the concept of environmental equity as it is increasingly understood today has its origins in the 1990s where evidence in the US was found of the discriminatory siting of polluting facilities near Black or Native-American communities (Bryant and Mohai 1992; Adeola 1994; Faber 1999). This more recent understanding holds that it is repeatedly already disadvantaged individuals and communities who suffer the greatest environmental burdens and receive least of the benefits associated with the decisions of government and industry and that this state of affairs results from those burdened being effectively excluded from the decision-making process in the first place. Such understanding follows from a number of assertions. These are, that:

1. Different groups of people have to bear different types of environmental burden and to differing degrees (i.e. there is not environmental equality, which of course says nothing about whether or not this situation is fair) (Agyeman *et al* 2003).
2. It is certain groups of people, such as those in an ethnic minority or of low income, who are bearing the greatest environmental burdens (while often not receiving the benefits) associated with a decision and that they are doing so repeatedly - thus in disproportion to the wider population (Bryant and Mohai 1992; Adeola 1994; Faber 1999).
3. This situation compounds existing disadvantage that such groups often face. For example they may have fewer resources with which to protect their health from these burdens while these burdens may also contribute to their areas becoming socially and economically undesirable places to live (Scottish Executive 2002; Agyeman and Evans 2004).
4. Such groups are not ultimately responsible for the above situation as it often results from those burdened being effectively excluded from the decision-

making process in the first place (Boardman *et al* 1999; Friends of the Earth: Scotland 2004).

5. This situation is iniquitous and represents an injustice.

In summary, the concept of environmental equity suggests that certain already disadvantaged groups are environmentally burdened more while at the same time benefit less than others and that they are not responsible for this situation which is therefore unfair. All that said it is worth noting that there has been considerable debate as to the extent to which this situation exists and whether or not it results from deliberate intent or historical legacy.

From this understanding of environmental equity (or perhaps more appropriately, environmental inequity), it is argued that the solution lies in the promotion of two interrelated components (USEPA 1998; CEQ 1997; United Nations 1998; Friends of the Earth: Scotland 2004; Agyeman *et al* 2003):

6. Distributive equity (i.e. equity in the impacts of a decision) which highlights the distribution of environmental impacts across different groups of people.
7. Procedural equity (i.e. equity in impacting upon a decision) which highlights the different opportunity, capacity and leverage that different groups have to participate in decisions affecting their environment (reflecting the second requirement of Rawls's Difference Principle).

However, it is important to stress that environmental equity does not demand that all environmental burdens are borne equally by all communities (i.e. a situation of “environmental equality”), but that it should not be already disadvantaged communities that bear the greatest burdens and repeatedly so (Faber 1999) (reflecting Rawls's Equal Liberty Principle and the first requirement of the Difference Principle).

What can be seen is that the environmental equity concept represents an important extension to usual environmental concerns. Traditionally, such concerns have focused on the impact that people have on the environment while the concept of environmental equity extends this to include an exploration of how the impacted environment then affects other people (see Figure 1).

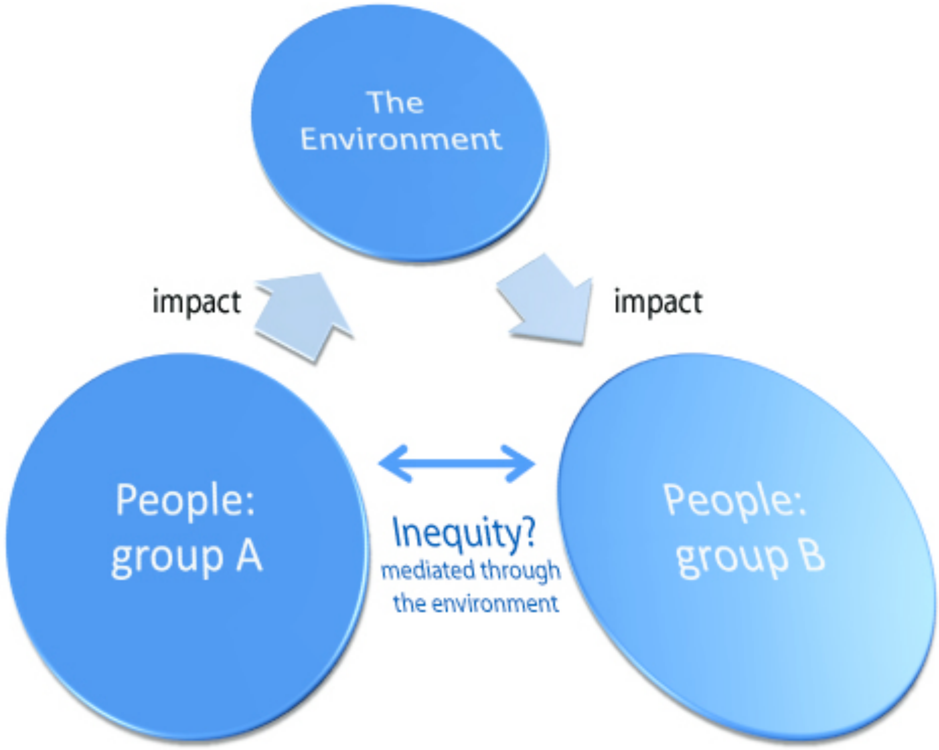


Figure 1: The dynamics of environmental inequity

This understanding of environmental equity suggests a generic methodology for its assessment which can be interpreted for the context of a proposed development and it is this interpretation which underpins the prototype assessment framework for proposed urban developments in the UK described later:

For the assessment of distributive environmental equity (see Figure 2):

8. Determine the nature and spatial extent (i.e. the 'footprint') of any likely significant environmental impacts associated with a proposed development.
9. Determine the extent to which target social groups (for example of particular ethnicity or income level) are present within the impacted population.
10. Determine the extent to which target groups are present within a wider 'reference' population.
11. Provide a comparison between 2 and 3 to indicate the extent to which the impact is disproportionately falling on target groups – the suggested measure of environmental inequity.

During these stages, in helping to promote greater procedural equity, the assessment should encourage the meaningful engagement of those communities, and especially target groups, likely to be impacted. This methodology can be repeated to explore the local environmental equity implications of alternative project options.

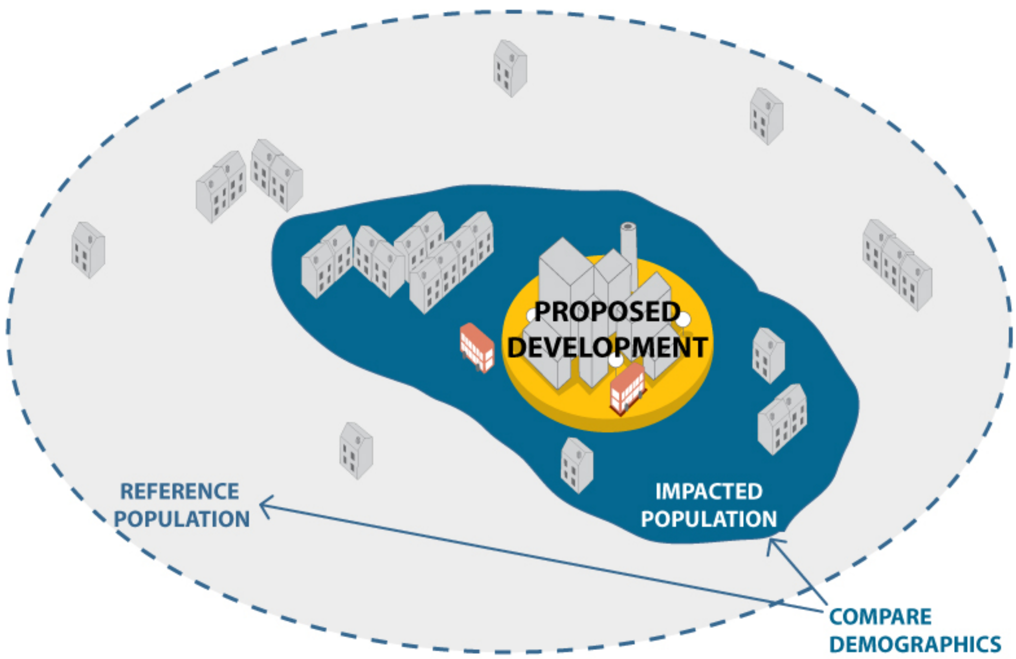


Figure 2: Assessing distributive environmental equity

3 The assessment framework: an overview

Research was undertaken to develop a prototype framework which would help decision-makers examine the environmental equity implications of proposed urban developments within the United Kingdom. A draft framework was developed to reflect the interpretation of environmental equity and the associated generic assessment methodology outlined above. This was refined using the findings from a number of workshops and interviews used to canvas the opinions of key stakeholders such as impact assessors, local authority officers, and environmental equity experts. Additionally, Environmental Impact Statements from a range of UK urban development projects (including large mixed-use developments, transport infrastructure, and sizable buildings such as hospitals) were reviewed to help identify typical example values for impact footprints and impact significance levels.

Before providing an overview of the framework it is appropriate to highlight a number of important issues regarding its intended scope:

Firstly, it is important to understand what exactly the framework can help assess. Identifying the nature and extent of any environmental impacts that may affect different groups represents an assessment of the extent to which there is a departure from environmental equality but does not in itself make any judgement as to whether or not the situation is equitable or just. That said it is an important step in being able to do so and because such an assessment is focused on examining, against the wider population, the impacts faced by groups likely to be already disadvantaged and least responsible for these impacts, it arguably moves closer still to what would reasonably be expected of an assessment of equity. However, it is recognised that there is ultimately no technical answer to the question “is the situation fair?” (Mitchell and Walker 2007) and the results of any assessment should be judged in the context of existing impacts and the wider benefits and burdens of the project.

Secondly, the framework does not assess, and does not seek to remedy, past environmental inequities in communities local to the project. Rather it seeks to guide decision-makers in such a way as to avoid the exacerbation of such inequities.

Finally, the focus of the framework is on the distributive equity of likely environmental impacts that may occur in local communities surrounding the project. However, guidance documentation accompanying the framework advises that development projects can be linked to environmental inequity at non-local scales. Carbon emissions associated with a project will contribute to climate change whose worst impacts are likely to be borne by the poorest peoples around the world who themselves are responsible for relatively few emissions. Additionally, the activities associated with a project's supply chain may result in negative environmental impacts in local communities at more distant locations.

3.1 Assessment levels

Within the framework the generic methodology for the assessment of distributive environmental equity outlined previously is expressed through several steps executed across three assessment levels of increasing complexity (see Table 1):

- Scoping level
- Main assessment: Level 1
- Main assessment: Level 2

Table 1: Framework levels and component steps

Framework steps		
For a broadly defined project:		
Scoping level Assessment	Step 1	Understand the characteristics of the likely environmental impacts
	Step 2	Understand the characteristics of the likely impacted and wider population
	Step 3	Determine the need for and coverage of a main assessment
		Repeat above steps for any project alternatives and compare
As project becomes increasingly defined:		
Main assessment level 1 or level 2	Step 4	Map the predicted impact footprint
	Step 5	Determine demographics of the likely impacted population
	Step 6	Identify appropriate reference population(s) and determine associated demographics
	Step 7	Determine environmental equity implications (compare demographics)
		Repeat above steps for any project alternatives and compare

The aim of the framework's scoping level assessment is to establish the need for, and coverage of, any main assessment by determining which, if any, environmental equity issues are relevant to the proposed development. Scoping involves the identification of relevant environmental impacts as well as an initial exploration of their likely spatial extent (i.e. of their "Probable Impact Footprint" or PIF) as well as the population who would be likely impacted (i.e. those within each PIF) (see Figure 3).

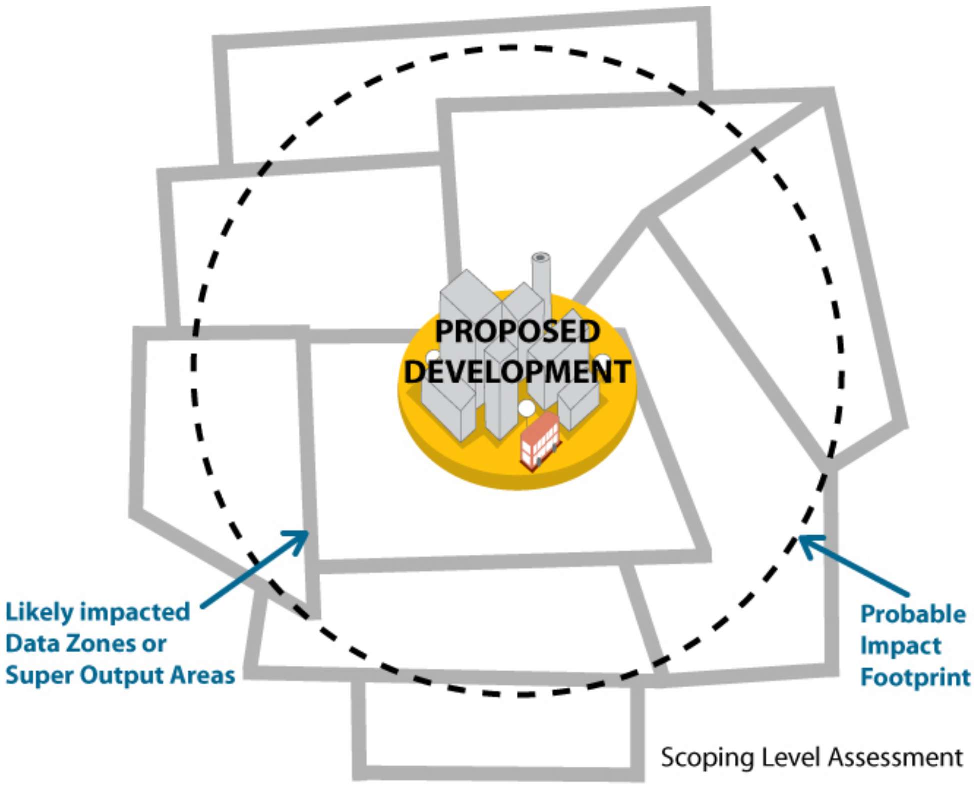


Figure 3: Scoping level assessment

The aim of the framework's main assessment levels is to determine the extent of the possible environmental equity (or more accurately, inequity) associated with the proposed development. Level 1 assessments are designed to communicate the broad environmental equity implications of the proposed project. As such they require the broad overall impact for each of a number of defined zones (such as Data Zones or Super Output Areas: see later for an explanation of these) that fall within each PIF to be determined (see Figure 4). Level 2 assessments are designed to provide a detailed investigation of the environmental equity implications of the proposed project and to be used in situations of greater controversy or uncertainty or when the inequity of impacts is likely to be particularly large. These assessments require significant involvement of the local community as well as the collection of demographic data via a number of different sources (see later). For a Level 2 assessment, within each PIF, environmental impacts are profiled to give contours of particular Environmental Impact Significance Levels (EISLs) and the demographics of those residences within each contour are determined (see Figure 4).

For each assessment level the demographics of those communities likely impacted are compared with the demographics of identified wider reference populations to explore the environmental equity implications of the proposed development.

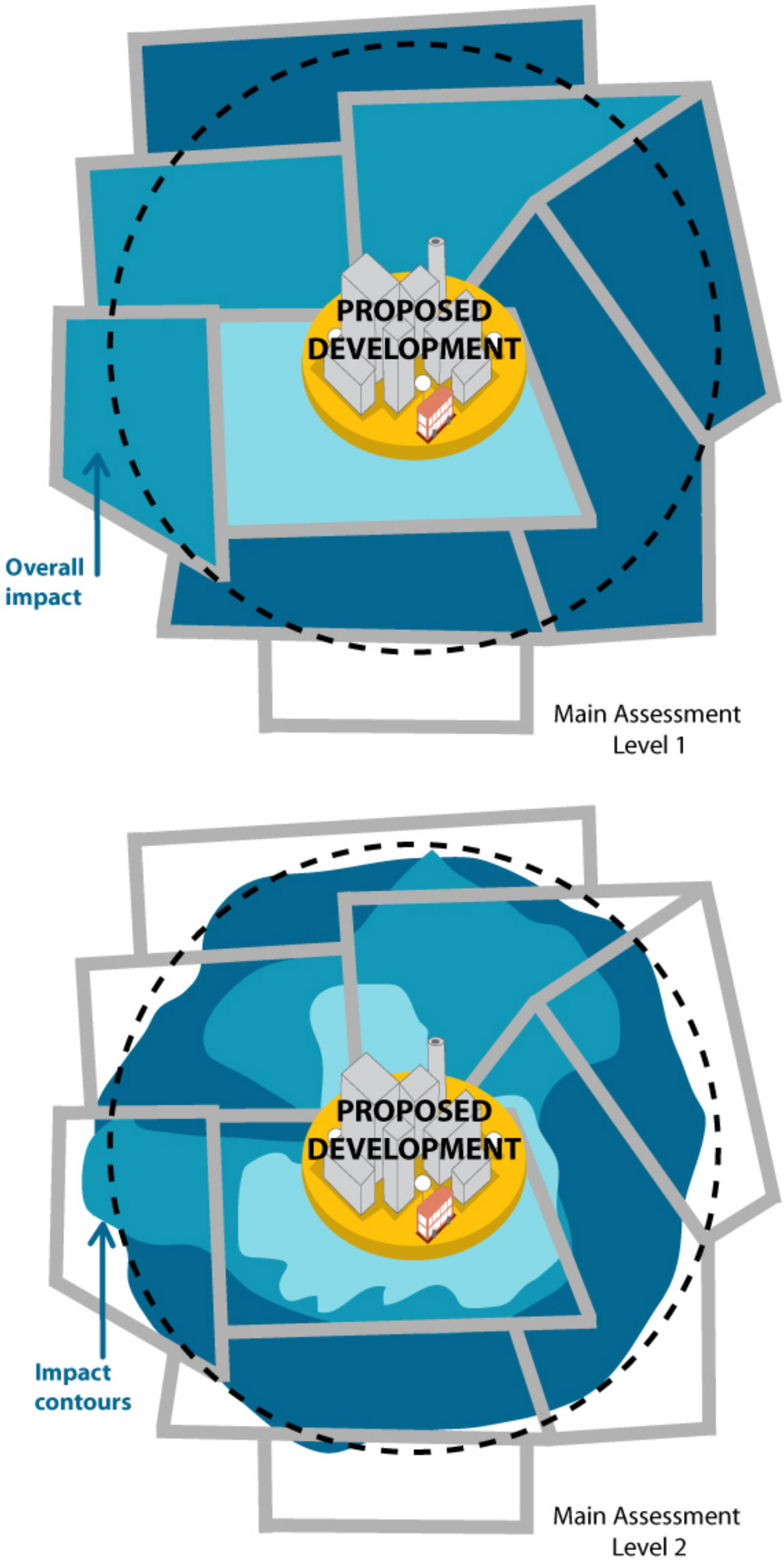


Figure 4: Main assessment (level 1 and level 2)

3.2 Issues and impact footprints

Each assessment level contains a number of assessment routines which interpret the component steps of the assessment level for a number of key environmental equity issues associated with a proposed development. These issues are:

During construction, the distributive equity of:

- Noise impacts
- Air quality impacts
- Community severance impacts (i.e. impacts on movement)

During operation, the distributive equity of:

- Noise impacts
- Air quality impacts
- Visual impacts
- Impacts on property and facilities (i.e. impacts relating to property encroachment and service provision)
- Community severance impacts

Where relevant, the assessment routines allow for an exploration of the distributive environmental equity of:

12. Direct environmental impacts, both good and bad, likely to result from the proposed development. Such impacts are centred on and extend around the development.

13. Indirect environmental impacts, both good and bad, likely to result from any altered traffic patterns (in the wider existing road network) associated with the proposed development. Such impacts are centred on and extend around links in the existing wider road network.

Each assessment routine also includes example values for PIF size and for EISLs relevant to urban developments.

3.3 Target social groups

Environmental equity assessment examines the extent to which particular target social groups are exposed disproportionately to environmental impacts with the focus for analysis being those groups that are widely considered to be already disadvantaged. In the UK environmental equity concerns are most likely to relate to deprived communities (Agyeman and Evans 2004; Walker *et al* 2003; Fairburn *et al* 2005). Consequently the prototype framework focuses on those considered income and/or employment deprived (with these types of deprivation representing the most significant components of the Index of Multiple Deprivation, the Scottish Index of Multiple Deprivation, and the Northern Ireland Multiple Deprivation Measure).

Accordingly, for Scoping level and Level 1 assessments the framework relies, by default, on the use of relevant publically available demographic data (such as the population size and percentage considered deprived) at the scale of Data Zone (Scotland), Lower Layer Super Output Area (England and Wales) and Super Output Area (Northern Ireland) (SNS 2009; ONS 2009; NINIS 2009). These are standard geographical scales over which neighbourhood statistics are collected and they often respect physical boundaries, have compact shape and contain households with similar social characteristics. Level 2 assessments require that these data are augmented using information gathered from other sources, such as: local planning authorities, commercial databases, surveys, public meetings, community leaders and local groups.

3.4 Reference populations

Previous environmental equity assessments in the US have commonly adopted as a reference community the population within the smallest jurisdiction (of the public authority) that contains the whole impact footprint such as the population within a metropolitan area (USEPA 1998; CEQ 1997). Additional reference populations at state or even federal level have also sometimes been used. The reason for this approach is that it is for such geographies that demographic data is often collected and that the associated public bodies are commonly those with authority over planning decisions and so likely to be the channels through which communities can voice concern. A similar approach has been adopted by the framework which suggests that for urban projects suitable reference populations include the population within the boundaries of the town, a city local authority boundary or the nation as a whole. The reference populations can be chosen to reflect the considered importance of the project (e.g. local, city-wide, regional or national) and, for level 2 main assessments, a routine is given to determine population demographics for reference populations based on non-standard geographies.

Importantly, the framework's documentation highlights that the spatial scale of the assessment in terms of the area considered as the impact footprint and the area considered to contain the reference population can both influence the result of the assessment and these should be chosen with care and may require revision during the assessment. The spatial scale of the assessment should be chosen to ensure that data provided accurately reflects the spatial context of particular projects and thus provides meaningful information to aid decisions and communicate performance. For example as deprived populations may be concentrated in urban areas so a comparison made with the population at city level may show less disproportionality then a comparison made with the population at regional or national level which may be appropriate if the project is of regional or national importance. Additionally, the size of impact footprints may need to be revised and the area of analysis extended if initial assessments predict significant impacts at the outer edge of the footprint.

3.5 The equity of impacts

Depending on the type of impact, the assessment routines are designed to provide data to be logged on one of two “demographic comparison tables” (DCTs) which have been developed for use within the framework. These tables are structured to facilitate a number of comparisons important to any assessment of the equity of a proposed project’s environmental impacts:

The disproportionality of impacts

Central to such assessment is a consideration of the extent to which a development’s negative environmental impacts (burdens) are likely to be borne by a population considered disproportionately deprived in comparison with the wider population. This is examined by comparing the percentage of the population considered deprived that is likely to be exposed to a project’s negative impacts with the percentage of the population considered deprived within the wider reference population. The difference in the percentages provides an indication of the extent to which impacts are likely to fall disproportionately on those considered deprived. Additionally, within the DCT information on the actual population sizes is also collected as an examination of percentages alone will mask the actual numbers of people impacted (this is particularly important when comparing various project alternatives which may show similar percentages but impact different numbers of people).

Furthermore, the framework's guidance documentation advises that during environmental equity assessments consideration should be given as to whether or not any difference in population percentages and sizes represents a meaningful difference. Also, assessors are advised to consider the extent to which, within the impact footprint, any deprived population makes up a large proportion of the total impacted community as a comparison with a wider reference community can still suggest disproportionality even if the percentage of the impacted population considered deprived is small (for example 5 % within the impact footprint compared to 6% within the reference population).

The distribution of environmental benefits and burdens

Another important consideration is the distribution of a project's likely environmental benefits and burdens among those considered deprived and not deprived. This is examined by considering the size of the populations considered deprived and not deprived that are likely to be benefited, burdened and to see no change as a result of the project and although the focus of the framework is on the equity of environmental impacts, the results of any assessment can be used to inform a wider analysis of the distribution of a proposed project's social, economic and environmental costs and benefits aligning with wider sustainable development goals.

4 Conclusion

A concern for environmental equity is at the heart of sustainable development yet it is rarely addressed explicitly in urban and built environment sustainability assessment tools. Accordingly, it is arguable whether current tools do indeed examine the true contribution that urban developments make to sustainable development. Thus, there is a need for new tools that address environmental equity concerns and that inform urban sustainability assessments. The generic assessment requirements outlined in this paper can provide the basis for the creation of such tools with the described framework developed as a prototype to examine how this can be done for a UK context in order to help create a fairer place.

References

Adeola, F (1994) Environmental hazards, health and racial inequity in hazardous waste distribution, 'Environment and Behaviour', 26, 99–126.

Agyeman, J and Evans, B (2004) Just sustainability: the emerging discourse of environmental justice in Britain? 'The Geographical Journal', 170, 2, 155–164.

Agyeman, J, Bullart, R and Evans, B (eds) (2003) "Just sustainabilities : development in an unequal world", Earthscan

Boardman, B, Bullock, S and McLaren, D (1999) "Equity and the environment: Guidelines for socially just government", Catalyst and Friends of the Earth, London.

Bryant, B and Mohai, P (eds) (1992) "Race and the incidence of environmental hazards", Westview Press, Boulder Colorado.

CEQ (1997) "Environmental justice: Guidance under the National Environmental Policy Act", Council on Environmental Quality, Executive Office of the President, Washington DC.

Costanza, R (1994) Three general policies to achieve sustainability. In: Jansson, A., Hammer, M., Folke, C and Costanza, R (eds.) "Investing in Natural Capital: the Ecological Economics Approach to Sustainability", Island Press, Washington DC, 392–407.

Daly, H and Cobb, J B (1989) "For the Common good: redirecting the economy toward community, the environment and a sustainable future", Boston, Beacon Press.

Dobson, A (1999) "Fairness and Futurity: Essays on Environmental Sustainability and Social Justice", Oxford University Press

Faber, D (ed) (1998) "The struggle for ecological democracy: environmental justice movements in the United States", Guilford Press, New York, 1998.

Fairburn, J, Walker, G and Smith, G (2005) "Investigating environmental justice in Scotland - Links between measures of environmental quality and social deprivation", report UE4(03)01, Scottish and Northern Ireland Forum for Environmental Research (SNIFFER), Edinburgh.

Friends of the Earth: Scotland (2004) "Love thy neighbour? The potential for good neighbour agreements in Scotland", Friends of the Earth Scotland, Edinburgh.

Global Commons Institute (2009) Global Commons Institute website: www.gci.org.uk accessed January 2009.

Haughton, G (1999) Environmental Justice and the Sustainable City, 'Journal of Planning Education and Research',18, 233

Honer, S M and Hunt, T C (1978) "Invitation to Philosophy: Issues and Options" (3rd Edition), Wadsworth Publishing Company, California.

IUCN-UNEP-WWF (1991) "Caring for the Earth", International Union for Conservation of Nature and Natural Resources, United Nations Environment Programme, World Wide Fund for Nature.

Markandya, A and Pearce, D (1988) Sustainable future: Natural environment and the social rate of discount, 'Project Appraisal', 3, 2–12.

Mitchell, G and Walker G (2007) Methodological issues in the assessment of environmental equity and environmental justice, in "Sustainable Urban Developments Volume 2: The environmental assessment methods", Deakin M, Mitchell, G, Nijkamp P and Vreeker R (eds), Routledge.

Muradian, R (2001) Ecological thresholds: a survey, 'Ecological Economics' 38, 7–24.

Neumayer, E (2003) "Weak Versus Strong Sustainability: Exploring the Limits of Two Opposing Paradigms" (2nd Edition), Edward Elgar Publishing.

MarkNINIS (2009) Northern Ireland Neighbourhood Information Service website: accessed January 2009.

ONS (2009) Office for National Statistics website: www.neighbourhood.statistics.gov.uk accessed January 2009.

Pearce, D and Atkinson, G (1993) Capital theory and the measurement of sustainable development: An indicator of 'weak' sustainability, 'Ecological Economics', Vol. 8, No.2, pp. 103–108.

Pearce, D and Barbier, E (2000) "Blueprint for a sustainable Economy", Earthscan, London, UK.

Rabl, A (1996) Discounting of long-term costs: what would future generations prefer us to do? 'Ecological Economics' 17, 137–145.

Rawls, J (1971) "A theory of justice", Harvard University Press.

Scottish Executive (2002) "Social justice: A Scotland where everyone matters - Annual Report", Scottish Executive, Edinburgh.

SNS (2009) Scottish Neighbourhood Statistics website: www.sns.gov.uk accessed January 2009.

UK Government (2005) "Securing the future: Delivering UK sustainable development strategy", HMSO, London.

United Nations (1992) "Agenda 21: An agenda for the 21st century: Report of the United Nations Conference on Environment and Development", Rio de Janeiro, 3-14 June 1992, United Nations Publications, New York, USA.

United Nations (1998) "Aarhus convention: Convention on access to information, public participation in decision-making and access to justice in environmental matters", United Nations.

United Nations (2002) "Report of the World Summit on Sustainable Development", Johannesburg, South Africa, 26 August- 4 September 2002. United Nations, New York.

USEPA (1998) "Final guidance for incorporating environmental justice concerns in EPA's NEPA compliance analyses", United States Environmental Protection Agency.

Wackernagel, M and Rees, W E (1996) "Our ecological footprint: reducing human impact on the Earth", New Society, Gabriola Island, BS, Canada.

Walker, G, Mitchell, G, Fairburn, J and Smith, G (2003) "Environmental quality and social deprivation. Phase II: National analysis of flood hazard, IPC industries and air quality", R&D Project Record E2-067/1/PR1, The Environment Agency, Bristol.

Walton, J S, El-Haram, M, Castillo, N H, Horner, R M W, Price, A D F and Hardcastle, C (2005) Integrated Assessment of Urban Sustainability, 'Engineering Sustainability', volume 3, issue 7, 57-65.

WCED (1987) "Our Common Future, World Commission on Environment and Development", Oxford University Press, Oxford, 1987.

Acknowledgements

The authors thank the members of SUE-MOT as well as all those who took part in the interviews and workshops and acknowledge the financial support of the EPSRC in the UK (Grant Reference: EP/C008030/1).

Urban planning and design methods for sustainable development

Fareea Shahreen, Angioletta Voghera
Politecnico di Torino, Italy

Urban planning and design for sustainable development is the process of shaping the physical setting for life to deal with the three-dimensional spaces in cities, towns and villages which concerns the environmental, social and economical factors. In contemporary context many cities and urban residents will be directly affected by many of the impacts of environmental changes, which include increased intensity and frequency of extreme weather events, heat waves, flooding from sea-level rise, water shortages and other effects. On the other side, in the big cities of Europe, migration is increasing greatly for the need of work, study purpose, treatment facility and the result is economical crisis, urban sprawl, high density, transport problem, increase energy use and pollution. The sustainable debate was not only dominated by environmental issues and economic concerns, but also included the social issues. Social sustainability refers to the personal and societal assets, rules and processes, physical boundaries of places etc. For concern of these themes, the argument of the paper is 'what are planners methods in the urban planning and design for sustainable develpoment ?'. The objectives are: (1) analysis of the sustainable changes in urban areas (2) analysis of the methods for urban planning and design in the context of these changes. This paper develops arguments in two phases. Firstly we analyze sustainable changes from urban planning and designing viewpoints. Secondly, we analyze different phases of urban development such as data analysis, site survey, initial concept develop, design development and constructions phase. After analyzing different phases of urban developments, we propose methods that will guide to develop urban projects, concerns with current urban changes, the environment-economic-social structure of an area. The method would set within a theoretical framework. If we did not concern about urban planning and design for these sustainable development then planners practice doesn't relate to the practical situations. For achieving a successful urban planning and design, we have to emphasis on the sustainable development of well–functioning environments.

Keywords: development, methods, sustainable, urban planning, urban design

1. Introduction:

Urban design is the process of shaping the physical setting for life to deal with the three-dimensional space in cities, towns and villages, and its objective relies in accordance with the vision of the future that they represent. Urban design involves coordinated and self-conscious actions in designing new cities and other human settlements or redesigning existing ones and/or their precincts in response to the needs of their inhabitants (Jon Lang, 2005).It is founded upon the social, environmental, political, aesthetic and economic importance of design in the public realm, serving the public interest and to provide opportunities and cultural dimensions. It focuses on the intersections between architecture, landscape design and planning. Urban design is related to urban planning, but it focuses more on the physical design of places and deals the more fine-tuned scale and more detail design approaches.

Urban planning is concerned with conceptual, scientific, and design approaches of land use planning (J.E. Rodiek, 2008). The simplest definition of urban planning is that it is the organization of all elements of a city/town planning or other urban environment, using different tools (land use plan, the operational plan or strategic plan, structural plan all are the parts of urban planning). The *land use plan* is identified two major ways in which a municipality may shape its pattern of land use – by zoning and regulations. Zoning regulations are usually passed by local authorities. Zoning regulates should decide the use of land in areas for residential, commercial, industrial, agricultural or other land use. In the same way, the *structure plan* is a high-level plan that shows the arrangement of land-use types and identifies public infrastructure, such as streets, schools, rail, reservoirs and natural features. The strategy plan is a policy document that describes in words and images a vision for developing a neighborhood, town, city or region. The operational plan is the implementation planning system purpose and general statement of program actions regarding ordinances, planning process and plan or implementation revisions and changes.

In urban planning and design for sustainability is an important issue in the 21st Century. Better urban planning and design of cities is a closely related challenge for sustainable development. This includes not just the design of public spaces, streets, neighborhood and homes, but the configuration of and greenway systems, regions growth patterns, transportation network, water and sewerage systems and even industrial process. Design systems requires thinking about how they relate to all other elements of a given community, combining physical planning(related to land use, infrastructure and the design of places) with public policy frameworks(includes tax regulation and economic incentives) that can support such changes. The paper is analysis the contemporary changes and problems arise in urban area and propose *the urban planning and design methods for sustainable urban built project development.* The main theme of the paper is to find out the urban planning and design methods for sustainable development.

2. Purpose of the methods:

In contemporary context many cities and urban residents will be directly affected by many of the impacts of environmental changes, which include increased intensity and frequency of extreme weather events, heat waves, flooding from sea-level rise, water shortages and other effects. On the other side, in the big cities of Europe, migration is increasing greatly for the need of work, study purpose, treatment facility. The result is in territorial sectors are the various demands for land in and around cities are becoming increasingly acute. The rapid, visible and conflicting changes in land use which are shaping landscapes in cities and around them as never before. This expansion is occurring in a scattered way throughout Europe's countryside (urban sprawl) and high density in inner side of cities. Also the transport problem, increase energy use and pollution. The sustainability debate was not only dominated by environmental issues and economic concerns, but also included the social issues. Social sustainability refers to the personal and societal assets, rules and processes, physical boundaries of places etc. In the perspective of urban project functions are not always well balance, that's why it creates higher density cities.

The writing of design theorists implies that the traditional methods are simple for the growing complexity of the world. For concern of these themes, the argument of the paper is "what are the planners' methods in the urban planning and design for sustainable development?". The paper explores ways in which urban planning and design method can be adapted to achieve measuring and evaluating large-scale urban projects in terms of the contribution for sustainable development.

The objectives are:
(1) Analysis of the sustainable changes in urban areas
(2) Proposed methods for urban planning and design in the context of these changes, which are adapt by the review of many urban planner , theoretical policies, professional experience and personal experience from professional practice.

3. Sustainability-definition

The concept of sustainability has been introduced to combine concern for the well-being of the planet with continuous growth and human development. Though there is much debate as to what the word actually suggests, we can view the definition offered by the World Commission on Environment and Development: "Meeting the needs of the present without compromising the ability of future generations to meet their own needs."

In its original context, this definition was stated solely from the human point of view. In order to include the idea of essential value, the meaning must be expanded to allow all parts of nature to meet their own needs - now and in the future. Designing for sustainable development requires awareness of the full short and long-term consequences of any transformation of the environment, social and economy. Finally we find the, urban planning and design for sustainability is the process of shaping the physical setting for life to deal with the three-dimensional spaces in cities, towns and villages which concerns the environmental, social and economical factors. In cities it is also important for landscape. Landscape planning prescribes alternative spatial configurations of land uses, which is widely understood as a key factor in planning for sustainability (Ahern, 2005).

3.1. Environmental sustainability: The average global temperatures rose by modest but significant amounts during the twentieth century; such changes are small by comparison with some of the very warring future scenarios. The 1990s was the warmest decade on record (since the 1860s, when full records began). In the last 30 years there has also been a reduction in snow and ice cover in the Northern Hemisphere of about 10 percent and a retreat of mountain glaciers in non-polar regions over the last 100 years. Also the average sea level rose by between 0.1 and 0.2 meters and rainfall increased over continental northern latitudes during the twentieth century, with a decrease in rainfall for sub tropical zone. Over mid- to high latitudes of the Northern Hemisphere in the second half of the last century there was a significant increase of cloud cover and heavy rainfall event. In cities, these impacts will negatively impact water, sewage, and energy distribution and transportation systems. They will damage buildings, urban trees and green spaces. They will increase illness and deaths in vulnerable populations. (Reference: Adrian Pitts, Planning and design strategies for Sustainability and profit, page-13, 2004). Our territorial planning, landscape and infrastructure are not designed for the new climate. Several features of modern cities interact with the changing climate to exacerbate the risks and increase vulnerability to climate change. These include:

- Asphalt, concrete and other hard surfaces in the city absorb radiation from the sun, causing the urban heat island effect, which exacerbates heat waves and puts pressure on electricity generation and distribution systems.
- Hard surfaces also prevent absorption of rainfall, creating runoff that carries pollution to lakes and streams and can overwhelm storm water systems, leading to sewer backups and flooding during heavy precipitation events.
- Combined sewers that carry both storm water and sewage are common in many city centers. Protracted or intense precipitation leads to overflows in these sewer systems, washing untreated pollutants into local water bodies.
- The concentration of people in urban centers puts pressure on vegetation and green spaces that could reduce heat, storm water runoff, pollution and social pressures.
- Far-flung supply lines combined with just-in-time shipping practices can result in shortages of needed goods when transportation is disrupted by extreme weather.
- Centralized power sources, longer distribution lines, and an increasingly interconnected grid increases vulnerability to blackouts when electricity demands are high – during heat waves, for example – and when storms occur. The impact of blackouts has also grown as homes and businesses have become more dependent on electronic control and communication systems.
- The concentration of people in large cities creates a large demand for water and can strain local water supplies, making them more susceptible to water shortages in drought conditions.
- Urban sprawl and competition for building sites has led to construction in locations such as floodplains or steep slopes that are vulnerable to extreme weather.
- Low-income city dwellers in substandard and poorly insulated buildings that increase the risks from heat waves and other extreme weather. Homeless people have almost no protection from these events. (Jennifer Penney, Ireen Wieditz,2007)

It is essential for future development; a clear relationship is established between urban design and local climate at macro/regional level as well as at the local micro-climatic level. On the basis of understanding the climate change to improve the design processes the planner use proper materials, skill, technologies and tools. In urban design the issues concerns are:

- Site layout, exposure and orientation.
- Form size and layout of new structure and open spaces.
- Relationship and effect on surrounding building, open space, topography and landscape.
- Use of passive and active design features matched to the climate.
- Choice the use of material, construction, service system.

3.2. Economical sustainability: During the last decades, the cities are accelerated extremely. Urban areas rather than states are the nexus of the movement of people, ideas, investment, communications and technology. Migration and its repercussions is an important element in cities. Migration is targeted to cities rather than countries. In the cities of Europe, migration is increasing greatly for the need of work, study purpose, treatment facility and the result is economical crisis, urban sprawl, high density, transport problem, increase energy use and pollution. Urban mixed use function projects improves access to employment, and enhances job opportunities.

The policy questions raised by this trend of economical sustainability are regarded as critical to the future well-being of our societies. When start an urban projects it is essential that create design according to budget. Cost estimation is the practical sector for develop an urban project. Through financial outline a project is decided that how much it could be proceed, decide labor cost, material cost, construction cost and so on. With out a cost calculation a project cannot run. Developers also try to find their job and analysis the market value for a project. Good urban design can sometimes cost more upfront, but it also offers significant benefits to the community. Benefits may spill over to a whole city, and this matters increasingly in an age in which the quality of an urban area is an important part of its comparative advantage. Well-designed urban areas have greater potential to be focal points for interaction, enterprise and innovation.

3.3. Social sustainability: Social sustainability refers to the personal and societal assets, rules and processes that empower individuals and communities to participate in the long term and fair achievement of adequate and economically achievable standards of life based on self-expressed needs. At a more practical level, social sustainability stems from improvements in thematic areas of the social realm of individuals and societies, ranging from capacity building and skills development to environmental and spatial inequalities. Sustainable communities are places where people want to live and work, now and in the future. They meet the diverse needs of existing and future residents, are sensitive to their environment, and contribute to a high quality of life. They are safe and inclusive, well planned, built and run, and offer equality of opportunity and good services for all.

Most of the work has focused on the 'compact city' versus 'urban sprawl' debate. Several studies claim that higher density of compact cities can enhance public transport systems, improve access to facilities and services and reduce social segregation (Burton, 2000). Compact cities may also entail shorter travel to work and fewer car journeys, which in turn reduce pollution, congestion and noise levels. From a sociological perspective, density is also able to impact on social interactions amongst city dwellers with uncertain results on the social sustainability of urban areas. Some authors argue that higher density can facilitate social interactions (Talen, 1999) whilst others contend that social ties and the sense of community may lower in high density areas (Freeman, 2001).

4. What is an Urban design methods?

Definition of *method* includes a number of key words such as procedure, systematic or orderly arrangement together with the idea of a clearly defined goal as an end product. The Pocket Oxford Dictionary described the definition of *method* as, 'way of doing something, systematic procedure'. The online dictionary *Die.net* defines methods as, 'a way of doing something, especially a systematic one; implies an orderly logical arrangement (usually in steps)'. Urban design method is an iterative process, cyclical in nature, use for procedures, achieve objective and implementation of plan.

Urban projects methods is a way that it guide a project – how to deal. When a project start the methods has guide a designer how to start a project, how to fix a goal, analysis and develop concepts for a particular project. Then the next step of planner is to draw the project, evaluate the drawing and talk with client. Sometimes conflict in designer with client, design with budget, people interest, political situations, etc. Then reviews the plans many times before implementation and when the project is start to imply in a site. May be the plan was change in future, but the planner had carry on the project in that way.

4.2 Urban design methods for sustainability:

In this paper we had discussed the urban built project sustainable development methods on the cities, fringes areas and neighborhoods. Because now-a-days urban projects of cities faces these sustainable changes rather than the villages. Urban design develop methods is indicate that type of development which doesn't damage the physical environment and which contributes to the city's ability to sustain its social and economic structures. Therefore the aim of the paper to establish a methods through some urban planners practical methods, authors review and our personal experience. The methods are develop by some stapes, in the following we discuss about the details of these steps:

4.2.1. Step-1: Objective:

Urban design is the visual motif of the city, or a particular part of the city, to achieve a high quality of life for the public. Livability is the goal of urban design. The goal and objective of urban design are social progress that recognizes the need of everyone, facilitating the restructuring and enhancement of the local economy, prudent use of natural resources and protection of the environment, increase the facilities, development the built structure in urban area. It also includes objectives and character of the area, continuity and enclosure, quality of the public realm, ease of movement, legibility, adaptability, diversity.

Urban planning and design for sustainable development basic objective is that, to deal with needs for present situation also compromise the future changes and needs. Development should not be confused with growth. Think about what planner want to achieve, the urban environment we are working with, and the community that lives there. The urban projects for sustainability had four objectives. These are:

- The urban projects are functionally well adjusted with the local environment.
- It also structurally sounds that for safety and future extension or modification.
- The project development policy always concern with the sustainable changes.
- Concern for public interest
- The project should have aesthetic quality.

From the starting of an urban design, some basic things need to introduce such as project programmes or schedule of uses and building floor space for a specific site. The ideal situation for the planner and the developer is to control design development that is already design and planning guidance available for a given site. This advice appears in a number of different places: it can be found in the local plan or in the master plan which may also include planning briefs, design briefs, planning frameworks, specific site guidance (topography, zoning, infrastructures, and community facilities), city centre action plans, planning act etc. When producing site development guidance a realistic look is important, for example the designer need to have a solid idea of the cost of achieving development and the land value. The title of the project is important as it gives clear ideas about the design requirements for any given site. These whole negotiation development control process was done between the developer and local authority.

4.2.2. Step -2:Survey:
It is essential to understand and examine the site properly. There are three main aspects of city analysis. The first concern is the legibility of the urban structure, that is, the way in which people perceive, understand and react to the environment. It concerns those qualities of a place which give it an immediate identity, one which is quickly perceived or grasped by its users to identify the important public and religious buildings, land mark, district. The second aspect of townscape analysis concerns the permeability of the environment, that is, the choice it presents to the user (like street, paths, edges, and parks, square). The third aspect, the visual analysis includes studies of urban space, the treatment of facades, pavement, roofline, street sculpture and an analysis of the complexity of visual detail which distinguishes one place from another.

For the sustainable changes we understand, “what urban environment we will work with?” and survey the size and characteristics of the urban environment. The surveys for sustainable changes are:

- *Understanding Place -* Sustainable design development begins with an intimate understanding of place. If we are sensitive to the nuances of place, we can inhabit without destroying it. Understanding place helps determine design practices such as solar orientation of a building on the site, preservation of the natural environment, etc.
- *Connecting with Nature -* Whether the design site is a building in the inner city or in a more natural setting, connecting with nature brings the designed environment back to life. Effective design helps inform us of our place within nature.
- *Understanding Natural Processes -* In nature there is not waste. The byproduct of one organism becomes the food for another. In other words, natural systems are made of closed loops. By working with living processes, we respect the needs of all species. Engaging processes that regenerate rather than deplete, we become more alive. Making natural cycles and processes visible bring the designed environment back to life.
- *Understanding Environmental, social and economical Impact -* The design attempts to have an understanding of the sustainable impact of the design by evaluating the site, the embodied energy and toxicity of the materials, the energy efficiency of design, construction techniques, zoning policy and social need.
- *Embracing Co-creative Design Processes -* Sustainable designers are finding it is important to listen to every voice. Collaboration with systems consultants, engineers and other experts happens early in the design process, instead of an afterthought. Designers are also listening to the voices of local communities. Design for all user (neighborhood residents or office employers) are becoming a standard practice.
- *Understanding People –* The project must take into consideration the wide range of cultures, races, religions and habits of the people who are going to be using and inhabiting the built environment. This requires sensitivity and empathy on the needs of the people and the community.

4.2.3. Step -3:Analysis:
When we would start the analysis we clear the steps are as following:

▪ **Why** we are analysis – what’s our purpose? Do we want information about specific parts of the urban site? If so, which ones? Or do we want the specific informative data?

▪ **What** information do we want – and how much? Do other council units want to use it for other projects? Are there any local issues, like long-running zoning, transportation, migration or others?

▪ **Who** do we want to collect these information? from council and the community?

It all depends on our purpose. When we choose our consultation method, we'll be consulting with people according of the age, ethnicity, literacy levels, and so on of the community. Asking people, in telephone, questionnaire, or face-to-face surveys, these three open-ended questions:

- What do you like about (place)?
- What don't you like about (place)?
- What would you like to change about (place)?

For a particular site we should analysis the sustainable data as following:

Environmental sustainability	**Economical sustainability**	**Social sustainability**
- average temperatures rise per year, for designing the shading and ventilation process - average sea level rise and rainfall per year, for find out the flood area and design in safe zone and height	-market analysis for economic status position for developing a project	- government policy -zoning -building law -'compact city' versus 'urban sprawl'

We also analysis some general topics, such as:

• *Strengths, Weakness, Opportunity and Threats (SWOT):* SWOT analysis is a useful technique for the collection and structuring the data. The SWOT analysis can assist clearer definition of the design and point the way to design solutions. The major theme in sustainable changes is people realm, environmental change, economical sector (for budget allocation) and government policy. As for example, we find through data collection that the site orientation and climate are very fluctuate situation. So it is guide and aware us, when we develop design.

• *Trend, forecast and scenario:* The analysis of trends, forecast and scenario, making predictions about the future. The plan was then based upon those predictions. It was found from experience that predictions and forecasts about the future can be wildly out when based on such calculations. The major events such as a change in political attitudes; a stock market crash and many other possible future events can be built into a series of different scenarios. These scenarios can be fed back into the forecasts, which in turn result in a set of different trends for any topic analyzed. As for example migration, we collect the data for particular city that how many people migrate in every year and why, so it could help us to calculate the users rates. For prepare an urban project is a long time process .Sometimes the present data are not appropriate for future, when the project is complete. If we prepare proposal with the concern of present and future data then the project would fulfill the users need.

• *Constraints and possibilities:* The constraints map contains information, for example, on the location and design of any approved projects such as road widening, sites with planning approvals, land use or building height restrictions, buildings designated as of historic interest, together with any important features of the land or its servicing. The possibilities map includes items such as areas ripe for development, possible linkages with adjacent areas in the city, features which are special to the area, groups of buildings of outstanding architectural significance, with a change of use, positions where development would enhance the appearance of the built environment and areas where landscape intervention would be advantageous.

• *Sieve mapping*: Analyzing constraints and possibilities can be expressed graphically as a series of sieve maps.

4.2.4. Step-4: Draw plan and design statement:
Drawing is an important element for achieve the destination. If drawing is incomplete or contradictory, builder cannot rely on the quality of the built outcomes. For large, complex and sensitive sites, design statements are needed to help applicants to explain their approach. For all situation some steps of drawing are required, these are:

- o Site and area diagram
- o Constraints-limits to development
- o Opportunity- scope for development
- o How development will integrate with the town or village and enhance character
- o How the site layout of access, buildings, space and parking make the best use of the site and work well.
- o How sitting, scale and massing relates to the area
- o Reasons for its appearance (elevation, ground surface)
- o How the design is sustainable (energy efficient, long lasting, accessible to all, safe and easy to maintenance).

4.2.5. Step-5: Evaluation of plan:
Moderate to large-scale urban design projects are aimed at improving social, economic and infrastructure conditions rather than focusing on the single objective of physical urban renewal. For that, projects aimed at regenerating inner cities are planned as a series of interrelated actions in which the increase of employment levels is interlinked with sustainable improvement in general. For this type of project the issue of methods needs to be considered from an economic and social perspective. Such as,

* *Economic evaluation of urban design:* The most important tool used to carry out an economic evaluation of urban design projects is *cost–benefit* analysis.

* *Environmental impact assessment:* Assessment the impact on the physical environment, quality of air, water, soil, cultural heritage conservation areas, animal environment, landscape, climate.

* *Identification of impacts:* Identify the impact on local economy, local environment, aesthetic and cultural values, Infrastructure.

Evaluation occurs at many levels ranging from meeting technical demands to the ability to gain public acceptance. It is the phase in which the preliminary plans generated in the synthesis phase are compared to the original goals and problem definitions. The evaluation are categories two way:

a) How well the solution fit the problem.
b) How readily the proposals can be implemented.

The problems are constantly changing. Developing solution for problems which are in a state of flux is like shooting at a moving target. Problem changes in time as citizen participation has gained important.

4.2.6.Step-6: Alternative of plan:
When generating methodology, there should be scope for alternative design solutions. This part emerge design concepts which reflect an understanding of the constraints of the problem and propose optimum solution. In this phase, the data gathered and the analysis of the problem must be translated into proposal for action. In these phase, there may be a number of concepts proposed. There is usually more than one way to solve a particular set of problems. Alternative plan is approach the old problem in new way. It analysis and present data in different way .

Sometimes the conversation of client and consultant are conflict in one plan. So it is important the alternatives plans that present possible action in given situation.

4.2.7. Step-7: Presentation:

Design as a process based on conversation and perception. In essence this means how designers come to understand problems and get ideas about solutions through a process that is conversation-like. Presentation is the tools available for expressing urban design ideas. It discusses, in particular, the style of report writing, effective public speaking, the use of drawings, three-dimensional material and the computer in the presentation of the urban design project. Presentation tools depend on the project, its document, skill and audience.

4.2.8. Step-8: Choice of plan:

After survey, analysis, review of plan, series of meetings with the client, planner, consultant and others, the discussion address to consider a plan for implementation. All urban designs are ultimately shaped not only by design ideas but also they should consider-

– The sustainable changes concern in plan which consider the needs for future
– Public and private sector marketing decisions and sources of financing.

After choice the plan there are two important steps towards implementation, these are:

- *Framing the permission:* Planning permissions are one of the most sensitive tools available for controlling the quality of design. The plan was grant by the authority with legal law for building and zoning conditions. After all the process was completed there was a question that the design are maintain the law of the country. Different country had different law and building act. Zoning system are also particular (like- residential, commercial, etc) or should be mixed use, it depend on the area and their use.
- *Keeping involve after planning permission:* After permission, the planning is to start practical works, and can be watered down and subcontracted, and the vision lost. In that time the planner job is to keep track on this.

4.2.9. Step-9: Implementation:

When we start to implement a project in a particular site, we need some documents-

• *Site layout requirements*: These may include, among other things, minimum setbacks (minimum distance from structure to front, side, or rear lot line), maximum percentage of site that may be covered by structure, placement of driveways or curb cuts, parking requirements, screening requirements and limits on the size or placement of signs.

• *Requirements for structural characteristic*: These may include maximum height of structure, maximum number of stories, and maximum floor area of structure. The last is often cast in terms of floor area ratio (FAR), which indicates a maximum permissible ratio of floor area to site area.

• *Uses to which structures may be put*: Zoning ordinance will generally specify which uses are permitted and which are not in a particular area. Like residential area, commercial area, etc zones are different from one to another for functional structure.

• *Procedural matters*: A common arrangement is that the building is the permit application. The ordinance will generally also specify an appeals procedure by which an applicant can apply for relief.

Project management is the important factor to the setting-up of the project, implementation at the construction stage of the process. Project management was used as a powerful way of controlling communities and to convince them towards a clearly established goal. The key to successful project management is to actually follow the project planning , monitoring with the current situation and keep track of how the project is progressing. Projects management is an important part of project control and keeping the project plan up-to-date.

Planning is a continuous process that begins with a vision and establishes goals, objectives, policies and recommendations to achieve that vision. Planning must recognize existing conditions to the extent that they affect the future. The results of the implementation process to achieve that vision are evaluated, and the goals, objectives, policies and recommendations are modified and readopted. The planner often receives a range of requests for changes, many of which need careful scrutiny. Reviewing the scheme on site as it is built, preferably with the developer, is most valuable for picking up critical aspects of detail. In practical situation there was lack of project monitoring system, so the project was completed but not a successful design. So for design methods and review systems is very important in practice of urban design.

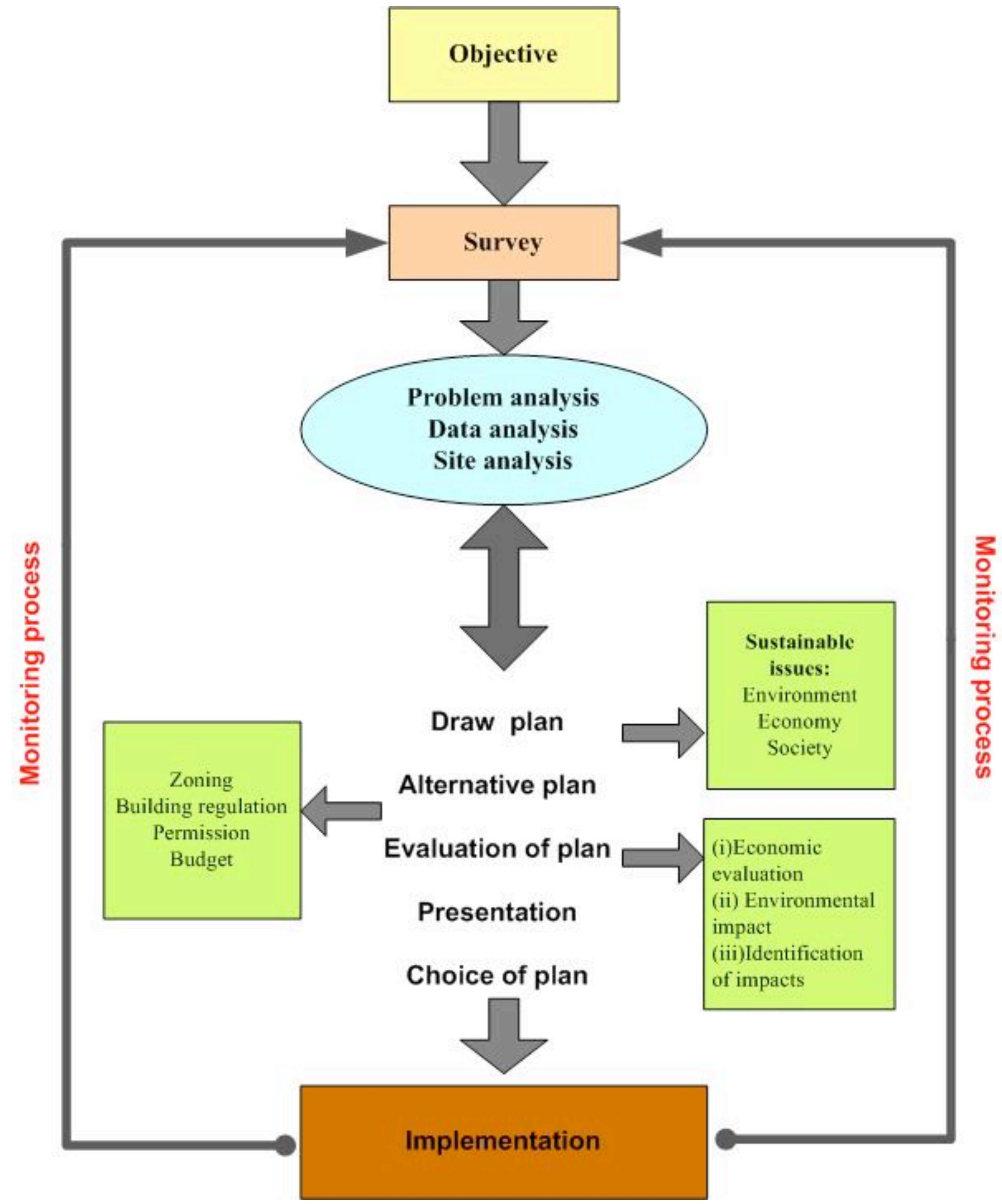


Figure: Propose design method

5. Conclusion:

The whole paper describes the methods for urban build project for sustainable development that will help to asses for future urban project development. We summarize the paper in the way that, we have followed the method step by step. First we fixed an objective, secondly survey and analysis of the site and data. Then draw plans, improve plan, consults with client, evaluation of the plan, alternative solution of plan and choice a plan. In these drawing process plans may be change several times .When we are do these we must aware of the zoning, law , regulation and permission from the local authority of planning. Other sectors are public interest, budgets are important. All urban designs are ultimately shaped not only by design ideas but also by public and private sector marketing decisions and sources of financing. Then the implementation step, which take a long time- sometimes year after year. So in implementation level we were monitoring the process from site analysis to implementation, because in respect of the time the starting conditions of site are different from the project implementation time. Sustainable issues, functions, cultural dimensions are change due to time. So after certain time to time it is required to analysis the project. The implementation of more sustainable practices now is essential so that we can enjoy a great quality of life today while ensuring that future generations will also have the resources they will need.

Reference:

Books:

Alexander Garvin, (1996), *The American City: What Works and What Doesn't,*

Adrian Pitts, (2004), *Planning and design strategies for Sustainability and profit,*

Bryan Lawson, *What Designers Know, (2004)*

Bryan Lawson, *How Designers Think: The Design Process Demystified,(2005),* fourth edition

Cliff Moughtin with Peter Shirley, *Urban Design: Green Dimensions, second edition,*(1999),

Cliff Moughtin, *Urban Design: street and square,*(2003)

Cliff Moughtin, Rafael Cuesta, Christine Sarris and Paola Signoretta, *Urban Design:* Methods and Techniques, (1999),

David Grahame Shane, *Recombinant Urbanism: Conceptual Modeling in Architecture, Urban Design and City Theory,*(2005),page 79-138,

Great Britain Dept. of the Environment, (2000), *By Design: Urban Design in the Planning System: Towards Better Practice,*

Henry Sanoff*, Community Participation Methods in Design and Planning,* (1999), page 1-32

Jon Lang, *Urban Design: A Typology of Procedures and Products, Illustrated with over 50 Case Studies,*(2005),

Jon Lang, (1994), *Urban Design: The American Experience,*

John M. Levy, (2002), forth edition, *Contemporary Urban Planning,*

John F. Benson, Maggie H. Roe ,(2007), *Landscape and Sustainability*

Ian Robertson Sinclair, Richard Hayward, Sue McGlynn, Oxford Polytechnic Urban Design, (1993), *Making Better Places: Urban Design Now*, page 19-23, 53-58,

Matthew Carmona and Steve Tiesdell, (2007), *Urban Design Reader,*

Stephen Maxwell Wheeler ,(2004),*Planning for Sustainibility creating livable, equitable, and ecological communities*

Tony Hall, (2007).*A Proactive Approach to Urban design,*

Articles/publications/web link:

Andrea Colantonio, *Social Sustainability: An Exploratory Analysis of its Definition,* *Assessment Methods, Metrics and Tools* (July 2007)

Jennifer Penney, Ireen Wieditz, (2007),*Cities Preparing for Climate Change*

Graeme McIndoe, Dr Ralph Chapman, Chris McDonald, Professor Gordon Holden, Associate Professor Philippa Howden-Chapman, Anna Bray Sharpin, (June 2005), *The Value of Urban Design, The economic, environmental and social benefits of urban design,*

Alexander R. Cuthbert, (2007) *Urban design: requiem for an era – review and critique of the last 50 years,*

Helen Briassoulis, (May 2005) *Land-use policy and planning, theorizing, and modeling: lost in translation, found in complexity,*

William McDonough & Partners,(2000), Design for Sustainability

Web link:

http://www.necsc.us/docs/ORNL_Design_Final.pdf

http://www.wellington.govt.nz/haveyoursay/meetings/committee/Strategy_and_Policy/2005/16Feb0915/pdf/05_UDprotocol.pdf

http://www.markham.ca/Markham/Departments/Planning/

http://www.urbandesignaustralia.com.au/images/Docs/Papers/DaleDicksonGOODURBAN%20DESIGN.pdf

http://www.mfe.govt.nz/publications/urban/design-protocol-action-pack-mar05/html/page2.html

http://www.resalliance.org/files/1172764197_urbanresilienceresearchprospectusv7feb07.pdf

http://www.mcgill.ca/urbandesign/what/

http://www.isf.uts.edu.au/publications/SDGURA.pdf

http://www.arch.hku.hk/research/BEER/sustain.htm#1.1

http://www.epa.qld.gov.au/publications/p01350aa.pdf/Sustainable_Urban_Development_Program.pdf

Incorporating energy use into the economic level of leakage model

Camilo Muñoz-Trochez, Sam Kayaga, Ian Smout

Loughborough University, UK

The alarming growth of water scarcity, coupled with widespread environmental degradation, has brought into focus the need for planned action to manage water resources in a more effective and sustainable manner. This is compounded in the water services industry by intensive energy use that leads to substantial carbon emissions into the atmosphere. This energy usage is set to increase in future, as it becomes necessary to develop newer and more energy-intensive water sources for growing cities and/or to meet higher service quality levels. Whereas energy optimisation for water treatment and pumping has recently gained a lot of research attention, there are minimal empirical studies on the energy dimension of water loss management in water distribution networks.

Increasingly, water utilities all over the world are adopting concepts for water loss management, which have been developed by the International Water Association (IWA) in particular through research and demonstration activities undertaken by the IWA Taskforce on water loss management. One of the key steps in leakage management strategy is the determination of Economic Level of Leakage (ELL), based on factors such the prevailing network conditions, water tariffs and the utility's level of technological sophistication.

Much of the work on ELL which has been reported in the literature is concerned with determining the short-term economic levels of leakage associated with the strategies of active leakage management and speed and quality of repairs. However, there is little empirical data on determination of the long-run ELL that incorporates environmental and social costs/benefits that affect society as a whole, such as energy use and its impact on the environment. Energy consumption in each of the four IWA water loss management approaches (i.e. improved speed and repair of leakages, pressure management, active leak detection and pipeline and asset management) could be determined, measured or computed to provide a more complete and environmentally-responsive economic level of leakage.

This paper will describe the various aspects of energy consumption related to these water loss management approaches and report on preliminary findings of a study being conducted as part of the EU-funded SWITCH project. SWITCH is a multi-disciplinary and integrated research project that aims to create a paradigm shift to sustainable urban water management 'for the city of the future'. The research described in the paper uses a case study of the city of Zaragoza, Spain to develop a model for the determination of long-term ELL that incorporates energy use, considering all the four approaches of water loss management: improved speed and repair of leakages, pressure management, active leak detection and pipeline and asset management.

Keywords: economic level of leakage, energy, leakage management, water distribution systems

1 Demand management for sustainable Urban Water Management

The global population has continued to increase rapidly, despite the fact that the overall growth rate and net additions are decreasing. According to a recent UN world population prospects report, the world population reached 6.7 billion in July 2007, 5.4 billion of whom will live in the less developed regions (United Nations, 2007). Assuming a declining fertility rate, the world population is projected to increase to 9.2 billion by 2050, which increment will mainly be absorbed by less developed regions (ibid).

The water resources, which are vital for existence of life on the planet, have not only remained constant but have increasingly been polluted by the growing population. Yet the rate of abstraction of freshwater has grown rapidly in tandem with human population growth. For example human water use increased by a factor of six in the past century (Andresen, Lorch & Rosegrant, 1997). It is estimated that global water withdrawals will increase by 35% between 1995 and 2020 (ibid). As a result, per capita water availability is steadily declining. While global freshwater supplies are adequate to meet global demand for the foreseeable future, the world's freshwater is poorly distributed across countries, within countries and between seasons. Hence, practical distribution problems concerned with time, space and affordability lead to a widening gap between demand and supply in many parts of the world.

The water scarcity situation is compounded by the major impacts of climate change on the water resources, namely shorter duration of the precipitation seasons and an increase in hydrological extremes (Stern, 2007). Shorter precipitation seasons, coupled with overall larger annual precipitations lead to larger runoff volumes generated over shorter time intervals, which in turn creates complications in designing for storage and routing of floods. Furthermore, the opportunity time for groundwater recharge is reduced, which undermines the efficiency of conjunctive utilization of surface water and groundwater. If these climate changes continue at current rates, there is predicted to be a serious reduction in dry-season water availability in many regions of the world within the next few decades. One recent study predicted that a temperature raise of 2°C may result in 1-4 billion people of developing countries experiencing water shortages (Stern, 2007).

The water scarcity situation will get worse in the world's urban areas , which have grown to the extent that since early 2007, urban areas account for over half of the world's population. (UN-HABITAT, 2006). Between 2000 and 2030, it is projected that there will be an increase of urban population of 2.12 billion, with over 95% of this increase expected to be in low-income countries (UN-HABITAT, 2004). Parallel with this growth in population, the demand for drinking water has been increasing rapidly in urban areas, in line with raising living standards. Yet the number of viable water resources in any region is limited and has to serve competing requirements such as domestic, industrial, irrigation, fishing, navigation, tourism, recreational, ecological demands and waste disposal/assimilation.

The situation described above presents today's water sector professionals with enormous challenges of effectively managing the ever dwindling water resources to deliver water and sanitation services while minimizing the negative impacts on the environment. The 2002 World Summit on Sustainable Development (WSSD) recognised the need to adopt Integrated Water Resources Management (IWRM) for promotion of more sustainable approaches to water development and management.

IWRM is an approach that '…promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems' (Global Water Partnership, 2000, p.22). The principal components of IUWRM are supply optimisation; demand management; participatory approaches to ensure equitable distribution; improved policy, regulatory and institutional framework; and intersectional approach to decision-making (UNEP-International Environmental Technology Centre, 2003).

Demand management (DM), one of the IUWRM components may be defined as the development and implementation of strategies, policies, measures or other initiatives aimed at influencing demand, so as to achieve efficient and sustainable use of the scarce water resource (Savenije and van der Zaag, 2002). DM contrasts with the conventional supply-driven approach to water resources management, whose response to the ever increasing water demand is development of new water sources. There are five major categories of DM measures (White and Fane, 2001): those measures that (i) increase system efficiency at the utility level; (ii) increase end use efficiency; (iii) promote locally available resources not currently being used, such as rainwater harvesting; (iv) promote substitution of resource use, e.g. use of waterless sanitation; and (v) use economic instruments to bring about an improvement in resource usage, such as use of tariffs.

DM measures that a utility could introduce include universal customer metering to encourage economic usage of water; maintaining efficient and informative billing systems; detailed customer feedback systems that provide information on water use; comprehensive information, education, training and advisory services which assist customers who wish to take action to reduce their water use; provision of detailed water use analysis (audits) for water consumers in the various sectors; and financial incentives for purchase and installation of efficient water using equipment (Turner & White, 2007).

Other DM measures at the utility level include reduction in system losses, including timely leakage detection and repair; efficient operational procedures such as optimum operating pressure and reduced mains flushing or reservoir cleaning; controlling of street water points; institutional capacity building in the utility to raise the importance of DM measures; and ensuring accountability of staff of the water utility (Turner & White, 2007).

The results of DM not only include the reduction in water demand, water leakage and wastewater volumes but also the reduction in the size of infrastructure, both treated and wastewater. The economical benefits of demand management include an improve of the financial status of the water utility reducing operational costs and postponing investments in infrastructure. The most important social benefit of this approach is to give the users awareness about the value of water and the importance of saving it and use it efficiently. This paper describes research that is being carried out in the City of Zaragoza, Spain on management of water losses in the water distribution network.

2 Objective of the Study

This paper reports on a research study that is part of an integrated project funded by the European Union (EU), whose overall objective is apply IUWRM concepts for achievement of effective and sustainable urban water schemes in the 'city of tomorrow (i.e. projected 30-50 years from now)'. The five-year SWITCH (Sustainable Water management Improves Tomorrow's City Health) project aims at developing efficient and interactive urban water systems and services in the city's geographical and ecological setting, which are robust, flexible and responsive to a range of global change pressures. Zaragoza is one of the partner cities for the SWITCH project, and is a demonstration city for the research activities under the DM work package of the project.

The objective of the DM work package is to develop and test holistic DM tools, encompassing social, commercial and physical aspects, in order to reduce water wastage and provide educational materials for the benefit of service providers. This paper specifically reports on research and demonstration activities being carried out in one of the service zones of the pipe distribution network in Zaragoza to develop a model for the determination of long-term ELL that incorporates energy use for all the four approaches of water loss management: improved speed and repair of leakages, pressure management, active leak detection and pipeline and asset management.

3 Literature Review

3.1 Managing Physical Water Losses in Distribution Systems

Managing physical water losses in the distribution network is a critical aspect of water demand management. There are several benefits that will come out of effective and efficient water loss management by water utilities. Efficient water loss management will lead to lower production costs in terms of energy, materials and staff costs. Furthermore, reduced leakages will lead to higher system pressures, which will eliminate risks of having negative pressures in the pipeline. High system pressures will reduce the risks of pollution of the system flows, and ensure that no air-blocks are formed in the pipeline. Less water losses and high system pressures will also ensure that customers receive better service levels in terms of pressure, continuity, reliability and aesthetics. Also the potential of water savings from the leak detection and repair is between the 20 and 30% of the produced water (Cheong, 1991), for some systems it might be over the 50%. This can result in a direct reduction of the costs that is equal the value of producing the amount of recovered water.

Water loss management has received significant attention from the International Water Association (IWA), a voluntary body that brings together water sectors researchers and practitioners over the world. The IWA Task Force on water loss management was formed in 2002, with a mission to 'provide leadership in the development of effective and sustainable international best practice in water loss management'. The most outstanding innovations of the Task Force on water loss management was the development of a model providing the definition and components of non-revenue water, and the derivation of basic elements of strategy for managing water loss, shown in Figure 1.

Figure 1 shows that there are two components of physical water losses in any water distribution network: (i) Unavoidable Annual Real Losses (UARL) composed of small but numerous background leakages from pipe joints and fittings which are difficult to detect using current technology; and (ii) potentially recoverable real losses, made up of leakages of higher flows and pipe bursts, which require significant effort and investment on the part of the organisation to locate and repair them. The four arrows in Figure 1 represents the four strategies that could be adopted to 'squeeze the area' and reduce water losses to a bare minimum.

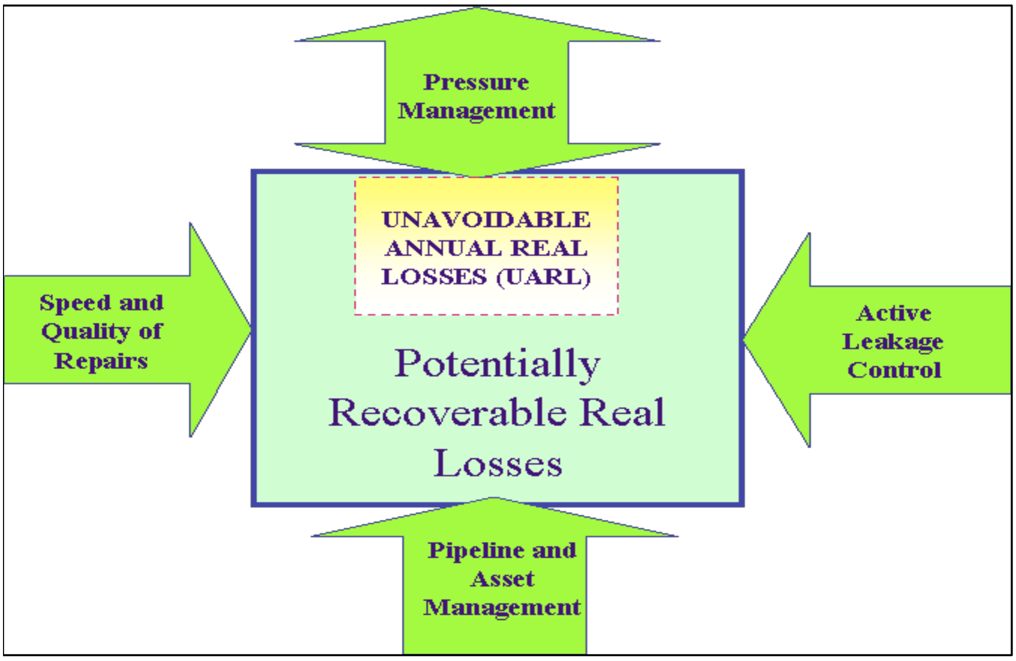


Figure 1: Components of water loss management strategy, as developed by IWA (Source: Liemberger and Farley, 2004)

The volume of water lost in a leakage is a function of the leak flow rate and the duration of the same until is completely repaired. This duration involves a detection time, a localization time and a repair time. The longer the time, the bigger the volume of lost water. Therefore the first strategy for leakage minimization shown in Figure 1 is to repair identified leakages and bursts in the shortest time possible, and to ensure that the quality of the repair work is beyond doubt.

Pressure management may be the most cost effective approach to manage real losses, depending on the system pressures and topography of the service area. In general terms, the higher the system pressure, the higher the leakage flow rate, as shown in Equation 1. L1 and L0 are the leakages at pressures P1 and P0 respectively, and N varies between 0.5 and 1.5, depending on whether the cross-sectional area of the hole varies (1.5 is for the varying cross-sectional area). This means that the change in leakage rates is higher in small leaks found in pipe joints and fittings, which are normally increasing in surface area (Lambert, 2001). Furthermore, pressure fluctuations play an important role in generating fatigue failures, hence the need to have a water supply system with minimised pressure fluctuations.

$$\frac{L_1}{L_0} = \left(\frac{p_1}{p_0}\right)^N$$

Equation 1 (Source: Lambert, 2001)

Not all the leakages that develop on underground water pipes come up to the surface of the ground. Water from leakages and burst follows a least resistance path, and can only appear on the surface if its flow rate and pressure reach a threshold value, which is dependant on several factors such as the ground conditions. Therefore, many small and medium term leakages will manifest themselves as underground leakages for a long time, until when this threshold value is attained. In order to minimise overall leakage rates in a distribution network, a water utility needs to carry out active leakage management, which is simply described as detection of leakages before they appear on the surface, using various technical equipment. Effective active leakage management requires high levels of technical and organisational capacities on the part of the water utility.

The fourth strategy for minimising leakages in pipes and other assets in the distribution network is maintaining and replacing them as and when their economic life is reached. Good asset management may be accomplished only when life cycles costs are well planned for in the financial model, and when the technical team keeps an asset maintenance management information system.

3.2 The concept of Economic Level of Leakage

Leakage control can be expensive, and water utilities need to achieve an economic balance between the costs of leakage control and the benefits there from. The Economic Level of Leakage (ELL) is the point at which the cost of reducing leakage is equal to the benefit gained from further leakage reductions (OFWAT 2007). In economic terms, ELL denotes a threshold value of leakage after which further resources committed in the leak reduction generate lower marginal benefits, as shown in Figure 2.

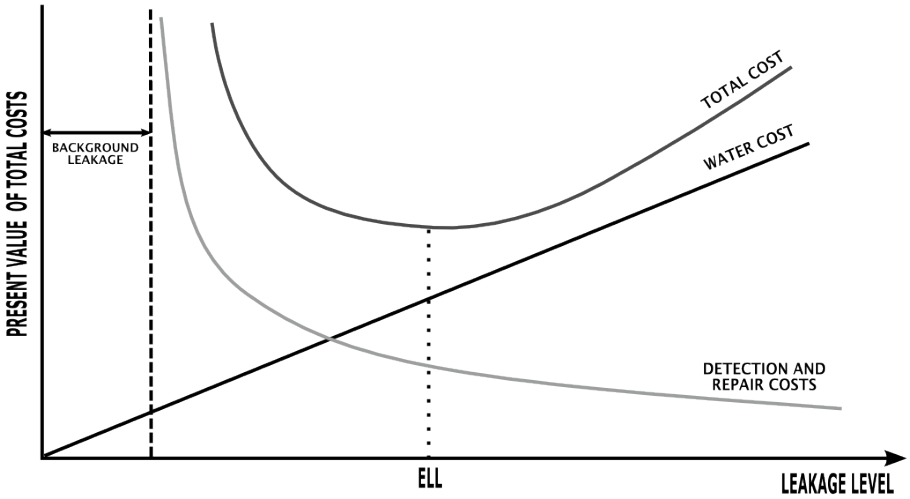


Figure 2:ELL Calculation

The graph in Figure 2 shows present value of economic costs associated with water losses. The cost of water refers to the costs of actually producing water of an acceptable quality, and of delivering this water to consumers. The costs of leakage management are those associated with detecting and repairing the leaks. The leakage costs decrease when the leakage level increases since is easier to detect bigger leaks, and the effect of detection and repair is more visible. The graph also shows background leakage as an asymptote – this is the sum of all the leakages in all fittings in the network, which are too small to be detected. This background leakage is a function of the leakage detection methods employed by the utility.

The OFWAT has been working on the process of including externalities on this model of ELL. An externality "...is any positive or negative impact arising from an activity that is not normally considered in the decision of the agent (in this case the Water Service Provider) undertaking the activity" (OFWAT, 2008). Such impacts impose a cost or benefit to third parties but not to the water utility.

These externalities are a result of the concept that the positive impacts or the avoidance of negative impacts have a value but there is no obvious market price (,or cost) which reflects third parties' willingness to pay. These externalities include social and ecological variables.

The current trends in economic theory had allowed the development and refinement of methodologies for the evaluation of external costs and benefits. However the inclusion of carbon valuation in this field is recent, as a product of including the cost of climate change and emissions of greenhouse gases.

One of the costs of producing water is the amount of energy used during the treatment and distribution process. The amount of energy consumed worldwide in water supply is more than 6552 Petacalories (26 Quads; 1 Quad = 10 ^15 BTU), is roughly equivalent to the amount of energy used by Japan and Taiwan together, about a 7% of the total energy consumption. (Alliance to Save Energy, 2004). And between 2 and 3 % of the energy consumption worldwide is used in the pumping, treatment and distribution of water in urban centers and industries.

After the staff costs, the energy consumption is the second most important expense in the water utilities. And this might be more critical in developing countries. The consumption of fossil fuels and the CO2 emissions associated with the energy generation is other very important variable that now is starting to be considered since the energy usage is set to increase in future, as it becomes necessary to develop newer and more energy-intensive water sources for growing cities and/or to meet higher service quality levels. The efficient use of water and energy is the most economically profitable way to achieve those objectives. For example, the energy consumption on water distribution systems could be reduced at least in 25% using high efficiency energy measures. (ibid)

3.3 Energy costs associated with approaches for managing leakage

3.3.1 Active leakage detection

Not only we have the fuel consumption used for transportation during the detection campaigns but also the energy consumed in the process of detection and the transmission of the information to a centre. The information obtained from the campaigns should be stored and managed to be used. Data obtained, such as pressure and flow rate, can be used for modelling, the system so it can be achieved a better understanding of the same, or verify or calibrate the same. The simulation of different scenarios is another use of this information. This allows the optimization of the system and the identification of possible problems such as low pressure zones or zones with high leak presence.

Since the 80's the shift from telemetry, to measure quantities from a remote site and transmit them to a data collection point for recording and processing, to Supervisory Control and Data Acquisition (SCADA) systems has allowed a more accurate, versatile, and cost-effective use.

A SCADA system compiles data about the operation of a distribution system and allows the automated control of system components (Jentgen and Wehmeyer 1994). The "supervisory" part alludes to the need of a person to supervise and make decisions about the operation of the distribution system.

For the leak detection in water distribution systems, we are interested in measuring flow rate and pressure, but the SCADA system can also measure temperature, pH, chlorine residual, turbidity, and conductivity. This depends on the sensors used, just like the energy consumption. It might not seem like a high consumption but is just a problem of scale. Bigger water distribution systems are going to need a bigger coverage and are going to have a bigger consumption.

However, is also interesting to see the potential of open-source hardware such as the Arduino microcontroller for the development of low consumption sensors and data transmission systems (Thompson, 2008).

The information is then collected in a centre. This centre has very special energy consumption characteristics. Tables 1 shows the increase in energy consumption in data centres during 2000-2006 in the United States.

End use component	2000 Electricity use (billion kWh)	2000 % (total)	2006 Electricity use (billion kWh)	2006 % (total)	2000 – 2006 electricity use (compound annual growth rate)
Site infrastructure	14.1	50%	30.7	50%	14%
Network equipment	1.4	5%	3.0	5%	14%
Storage	1.1	4%	3.2	5%	20%
High-end servers	1.1	4%	1.5	2%	5%
Mid-range servers	2.5	9%	2.2	4%	-2%
Volume servers	8.0	29%	20.9	34%	17%
Total	28.2		61.4		14%

Table 1: Electricity Use by End-Use Component, 2000 to 2006 (US Environmental Protection Agency 2007)

3.3.2 Improved speed and repair of leakages

With the use of control systems it is possible to monitor the incidents, the time taken for response, and the time taken to complete a job. This allows the monitoring of the staff, keep the standards of work and the identification of possible problems. This means that once more we have the need for the data centre and the energy consumptions associated with it.

But this approach has a high energy consumption associated with the repair process and the traffic delays product of this repairs. This allows the consideration of the use of less invasive technologies for the repair of leaks such as the trenchless systems.

The usual procedure for installing a pipe involves the digging of a trench, the installation of the pipe and the filling of the excavation. However this also means the repair of the streets or sidewalks that were damaged during the trench excavation. This repair process also involves extra crews and extra energy consumptions.

The trenchless technology is not a replacement for the trenchers or excavators. They still need to cut a hole in the ground, which is smaller than a trench and is easier to repair, and trenchless methods can't work in all kinds of soils. But they are a good option in difficult places and the range of savings are cited between 30 to 50% (Griffin 2004) from reducing the size of excavation, reduced restoration costs and, in most cases, the elimination of traffic obstructions. This technology can also be used for rehabilitation and repair of pipes.

The combination of GIS data and trenchless technology can help to avoid the possible problems with other pipes during the work.

3.3.3 Pressure management

A reduction in pressure reduces the leakage rates, the frequency of bursts and the energy consumptions. However, this also reduces the consumption volume of the users. The studies on energy and pressure management has gained a lot of attention in the research field going from optimizing the pumping schemes to developing new control technologies. Table 2 shows several payback periods for different approaches to the pressure management.

Function	**Typical Payback Period (years)**
Avoid the unnecessary operation of pumping equipment	0 – 1 it implies level automatic
To optimize the electromechanical efficiencies of the pumping systems	0.5 – 1.5
Control of pressure and output in the networks	1.5-3
Use of highly efficient motors	2 -3

Table 2: Typical payback periods for pressure management technologies and practices (Municipal Water Infrastructure Efficiency as the Least Cost Alternative)

4 Background on the City of Zaragoza, the study setting

The city of Zaragoza, situated in the central area of the River Ebro basin, is the capital of Aragón region in North-eastern Spain. Zaragoza, with a mean elevation of 199m above seal level, experiences a hybrid of continental/Mediterranean climates, characterised by long winters (about 121 days with temperatures lower than 10°) and long summers (about 150 days with temperatures higher than 17°). Zaragoza is situated in a semi-arid region with an average annual precipitation of 314 mm, and a potential evapotranspiration rate of 795 mm per year (Arbués and Villanúa, 2006; Arbués, et al, 2004). To mitigate against the widely varying seasonal flow rates of River Ebro, 138 dams have been constructed on the river since the 1930s, providing a total storage capacity of 687,300 m3 (Penagos, 2007).

The 2001 national census put the population of Zaragoza at 614,905 (a 31% increase with respect to the 1970 population), making it the fifth largest city in Spain (Arbués and Villanúa, 2006). While 96% of the city population currently live in the central cores dominated by high buildings (of between 6-12 floors), the suburban areas with single-family homes have shown a higher growth rate, in line with an increase in real disposal income (Arbués and Villanúa, 2006). As a result, the average household occupancy rate has reduced from 3.04 to 2.72 people per household between 1991 and 2001 (Arbués et al, 2004). The increasing income levels over the past couple of decades have invariably led to higher affluence, which has in turn resulted into higher household water consumption rates.

Water and sewerage services to the city residents are provided by Zaragoza City Council, through centralised municipal departments. Raw water for the city supply is abstracted from River Ebro, mainly through the Aragón Imperial Canal. Although there are plentiful groundwater resources in Zaragoza, underground water has not been exploited for the municipal water supply, mainly because it contains high concentrations of minerals such as sulphates, nitrates, sodium and magnesium (Arbués et al, 2004). To respond to the increasing water demand, the city council has in the past focused on supply-side options, namely abstracting surface water further away from Zaragoza, through construction of dams, barrages, aqueducts and canals, the development of the Yesa dam being the most recent such project (Arbués and Villanúa, 2006). This paper demonstrates how Zaragoza City Council is turning round to implement some aspects of IUWRM to respond to the growing water supply needs.

5 Research Methods

In Zaragoza, relevant data are being collected for assessing the four components of water loss management strategy shown in Figure 1, and District Meter Areas (DMAs) are being set up for measurement and detection of leakage in a case study area.

These data will be used for a first estimate of the ELL, which will be refined by looking at energy cost issues in more detail, including the savings in energy consumption through reducing leakage. This will show how the ELL may vary, depending on the financial cost of energy, and this analysis can be taken further to consider social and environmental externalities, e.g. the economic cost of carbon.

Data will include the energy consumption by the water utility in leakage control (including in travel and repairs) and by data rooms and servers, at different times of year, especially in summer. Some of the data can be calculated but energy surveys and measurements and time use logs will be used.

After obtaining this primary information, we will calculate an initial energy consumption value to review energy saving alternatives that allow the reduction of consumption and improve the leakage management process.

The need to consider the seasonality of the energy consumption is the most important variable in this study. Right now we are able to quantify a great part of the energy consumption in the different approaches for leakage management but we need data that covers a longer period of time. That is the most important variable in this study since the energy consumption varies during the times. Also we need to consider the different alternatives in the market for some of the tools used by the water utility in the leak management process to access the change in consumption and the impact in leak management of this new tools.

The field work in Zaragoza started in October 2008, since when District Meter Areas have been set up, flow and pressure loggers installed and the DMAs have been calibrated. The next stage is collecting data for energy consumption associated with each of the four strategies of water loss management.

6 Way Forward

Research on leakage in Zaragoza should provide a better understanding of the cost-effectiveness of current techniques of detecting and repairing physical losses at the system level, and of innovative techniques encompassing both physical losses and commercial losses.

Study of the Economic Level of Leakage will provide a focus for this, including the energy component.

7 References

Alliance to Save Energy (2003). Watergy: Agua y Energía: Aprovechando las oportunidades de eficiencia de agua y energía aún no exploradas en los sistemas municipales de agua, accessed at http://www.watergy.org/resources/publications/watergy_spanish.pdf

Andresen, P.P., Lorch, R.P. and Rosegrant, M.W. (1997) The World Food Situation: Recent Development, Emerging Issues, and Long-term Prospects, Food Policy Report, International Food Policy Research Institute, Washington D.C.

Arbués, F. Barberán, R. and Villanúa, I. (2004) Price impact on urban residential water demand: a dynamic panel data approach, Water Resources Research, 40(11), W11402, doi: 10.1029/2004WR003092.

Arbués, F. and Villanúa, I. (2006) Potential for pricing policies in water resource management: estimation of urban residential water demand in Zaragoza, Spain, Urban Studies, 43(13), 2421-2442.

Cheong, L.C. (1991). Unaccounted-for Water and the Economics of Leak Detection. 18th Int.Water Supply Congress and Exhibition, Copenhagen, 123(8), 709--718.

Global Water Partnerships (2006) Urban Water and Sanitation Services; An IWRM Approach, TAC Background Papers No.11, Stockholm, Sweden.

Griffin, J. (2004) Keyholing Attracting Renewed Attention Accesed at http://www.oildompublishing.com/uceditorialarchive/Feb04/febkeyhole.pdf

Jentgen, L, Wehmeyer, A (1994). SCADA Trends and Integration Perspectives. Journal AWWA Edition: Vol. 86 - No. 7 American Water Works Association / 01-Jul-1994 / 10 pages

Lambert, A. 2001. What Do We Know About Pressure / Leakage Relationships in Distribution Systems?. Proceedings IWA Specialised Conference: System Approach to Leakage Control and Water Distribution Systems Management, Brno, Czech Republic, Mayo 2001. June 2000, pp. 131-139

Liemberger, R. and Farley, M. (2004) Developing a non-revenue water reduction strategy, paper presented at the International Water Demand Management Conference, May 30- 3 June 2004, Dead Sea, Jordan, accessed at http://www.wdm2004.org/new_web/technical_session/files/roland_liemberger.pdf

OFWAT (2008). Best practice principles in the economic level of leakage, accessed at http://www.ofwat.gov.uk/aptrix/ofwat/publish.nsf/AttachmentsByTitle/pap_pos_pr09supdempolapp2-1.pdf/$FILE/pap_pos_pr09supdempolapp2-1.pdf

Pearson, D and Trow S.W (2007). Calculating Economic Levels of Leakage. Accessed at http://waterloss2007.com/Leakage2005.com/pdf/Calculating%20Economic%20Levels%20of%20Leakage.pdf

Penagos, G. (2007) Systems analysis of Zaragoza urban water system (Spain): A preliminary assessment of environmental sustainability, unpublished MSc dissertation, UNESCO-IHE Institute for Water Education, Delft, The Netherlands.

Thompson, C. (2008) Build It. Share It. Profit. Can Open Source Hardware Work? Wired Magazine, Issue 16.11. Accessed at http://www.wired.com/techbiz/startups/magazine/16-11/ff_openmanufacturing?currentPage=all

Turner, A. and White, S. (2006) Does demand management work over the long term? What are the critical success factors? Sustainable Water in the Urban Environment II Conference, Sippy Downs, Queensland.

Savenije, Hubert H.G. and Pieter van der Zaag. (2002) Water as an Economic Good and Demand Management: Paradigms and Pitfalls. Water International. 27(1): 98-104

Stern, N. 2007. The Economics of Climate Change: The Stern Review, Cambridge University Press.

UNEP-International Environmental Technology Centre (IETC) (2003) Integrated Urban Resources Management Strategy: Water, UNEP, Nairobi.

UN-HABITAT (2004) State of the world's cities, 2004/05, UN-HABITAT Report, Nairobi, Kenya.

UN-HABITAT (2006) State of the world's cities, 2006/7, UN-HABITAT , Nairobi, Kenya.

United Nations (2007) The Millennium Development Goals Report 2007, UN, New York.

US Environmental Protection Agency. (2007) Report to Congress on Server and Data Center Energy Efficiency: Public Law 109-431. Accessed at http://www.energystar.gov/ia/partners/prod_development/downloads/EPA_Datacenter_Report_Congress_Final1.pdf

White, S.B. and Fane, S.A. (2001) Designing Cost Effective Water Demand Management Programs in Australia, Water Science and Technology Vol. 46, No 6-7, pp.225-232.

Sustainable residential aged care: the influence of environment on carer work satisfaction and stress levels

Chris Landorf, Trevor Hilaire, Graham Brewer

University of Newcastle, Australia

Throughout the world populations are moving towards urban areas (UNFPA 2007) and in Australia as in many countries populations are also ageing (Australian Bureau of Statistics 2004; Vladeck 2005; Healy, Sharman et al. 2006; Maples and Abney 2006). This has obvious implications for environmental sustainability when viewed in the context of resource depletion and environmental degradation (Basiago 1999) but also considerable inherent implications for social and urban sustainability (Basiago 1999). Currently it is thought that the ageing populations will increase the demand for residential aged care (RAC) (Coombs and Dollery 2004; Birrell and Healy 2005; Howe and Healy 2005; Mitchell and Mosler 2006) with an increasing level of dementia specific care (Access Economics 2003). However the provision of these facilities represents a significant investment of resources and the community will benefit if these resources can be better utilised.

The argument is put forward that Quality of Life (QoL) for residents is the primary aim for RAC facilities and has been the subject of many studies predominantly from a care perspective (Willhelmson 2005) and while there is a strong relationship between QoL and care (Parker 2004) the World Health Organisation Quality of Life Group notes QoL as being multidimensional and difficult to define (Barnes 2002, Bowling 2007). This paper argues that this ill defined multidimensional term therefore has other factors that may affect care and QoL, and one aspect is the effect of environmental design.

The workplace environment can be a contributor to stress by providing stressors to which an individual reacts (Lloyd, King et al. 2002) and this individual reaction (Kinman and Jones 2005) can have a varying impact on physical and mental health (Parslow, Jorm et al. 2004). There are many particular stressors associated with RAC that may combine to cause stress with some being the emotionally charged nature of dealing with older people (Haggstrom, Skovdahl et al. 2005), working with cognitively impaired residents (Brodaty, Draper et al. 2003) and exposure to and dealing with death and dying (Michie, Ridout et al. 1996).

There is an association between quality of care and work stress/job satisfaction (Edvardsson, O.Sandman et al. 2008) and with an estimated 80-90% of care undertaken by carers (as distinct from registered nurses) they may be the 'linchpin' to the provision of quality care (Proctor, Stratton-Powell et al. 1998; Castle 2007).

Evidence is increasing that the physical environment affects both job performance and job satisfaction (Vischer 2007) and where the physical environment can introduce potential stressors (Aspinall 2001) it can also be used to assist work outcomes (Stokols, Clitheroe et al. 2002). Therefore if workplace stress can be affected by the physical environment and workplace stress also affects the level of care which is a part of QoL then RAC facilities will find it advantageous to consider the insulation of workers from stressors or even the promotion of spaces that stimulate care.

This paper identifies a range of candidates as design attributes for sustainable residential aged care facilities that can impact upon carer job satisfaction and stress, and outlines a pilot study intended to confirm/extend this model.

Keywords: ageing and the built environment, design, job satisfaction, residential aged care, work-related stress, working environment

INTRODUCTION

In 2007 the United Nations Populations Fund anticipated that by 2008 half the world's population would reside in cities or urban areas (UNFPA 2007). This has obvious implications for environmental sustainability when viewed in the context of resource depletion and environmental degradation (Basiago 1999) but also considerable inherent implications for social and urban sustainability (Basiago 1999). The overall efficiency and well being of a community enable it to function and maintain or enhance resources, including human or social resources, within the community and in doing so determine the sustainability of the community. Porta and Renne cite the works of Oscar Newman, William Whyte and Jan Gehl in determining the impact of the built environment on social well being (Porta and Renne 2005) which is a contributor to the complex multifaceted and changing nature of sustainability (Eden 2000) of the community. The integration of economics and social responsibility and the interconnection between human, natural and built systems has the ability to help or hinder the social process. In an effort to optimise an outcome from this mix O'Hara puts forward the proposition that the satisfaction of the needs of participants are necessary to establish a sustainable environment and therefore their input is an essential ingredient to the design of that environment (O'Hara 1999). This paper looks at a small section of the social environment in the context of this proposition.

Members of the community in the later stages of life require varying levels of care from very little, or self care, to much higher levels of care requiring a facility and services beyond those available in the family home. In Australia those in this latter group are cared for in a residential aged care facility (RAC) and are classified under the Residential Classification Scale (RCS) ranging from 8 for low care to 1 for the highest level of care (Australian Government Department of Health and Ageing 2006). In the past RAC had been somewhat institutionalised but changes were introduced by the Australian Government in 1997 to prepare the industry for an anticipated increased future demand and provide a more sustainable system. This paper investigates a way to make this new system more sustainable.

The paper will outline the anticipated growing need for RAC facilities in societies throughout large parts of the world and the importance of Quality of life as a principal aim in these RAC facilities. The argument will be made that there are stresses involved in workplaces and there are particular stressors involved in the care of dependent cognitively impaired people. Carers undertake a large part of the day to day care and the extent of this interaction has the potential to make a difference (positive or negative) in the resident's quality of life. The environment may have an effect on workplace stress and some possible candidates for adaptation of the physical environment with the potential to affect stress in RAC facilities will be highlighted. It will be proposed that suitable design of RAC facilities with the work stress/job satisfaction of carers in mind could affect the resident's quality of life and result in a more efficient sustainable facility with the resultant flow on to society. The need for further investigation will be noted and a current study will be outlined.

QUALITY OF LIFE IN AGED CARE FACILITIES

In 2003, 13% of the Australian population was over 65 years with 5% of that group in residential aged care (RAC) (Australian Bureau of Statistics 2006). However sustained low levels of fertility and medical advances (Bender 2004) increasing life expectancy (Pardasani 2004; Healy, Sharman et al. 2006) allied to the influx of the baby boomers (Vladeck 2005) are predicted to inflate these figures. People over the age of 65 years are anticipated to account for 20% of the Australian population with a 54% increase by 2023 (Australian Bureau of Statistics 2004). This pattern is repeated throughout the industrialised world (Vladeck 2005; Healy, Sharman et al. 2006; Maples and Abney 2006).

Whereas current indications point to an increase in the demand for residential aged care (Coombs and Dollery 2004; Birrell and Healy 2005; Howe and Healy 2005; Mitchell and Mosler 2006) not all people over the age of 65 years require aged care (Wiggins, Higgs et al. 2004). Peter Laslett (1996) sets up a scenario in "A Fresh Map of Life" where he outlines four "ages" with the 'Fourth Age' being an era that sees the individual return to dependency. These dependencies and the associated level of care determine the individual's suitability to ageing in place or the requirement for residential aged care which could be increasingly regarded as end of life (EOL) care (Ginsburg, Citko et al. 2005). In 2003 the median age of RAC residents was 85 years (Australian Bureau of Statistics 2006) indicating that it is the "fourth age" that will possibly exhibit the predominant demand for residential aged care (Coombs and Dollery 2004; Ginsburg, Citko et al. 2005) with an increasing level of dementia specific care (Access Economics 2003). However Howe (2003) notes that since 1986 the entry rate into RAC has decreased from 10.4% to 8.1% (Howe 2003) as people prefer to age in place (Pardasani 2004; Spanbroek 2005), a trend expected to increase as the Baby Boomers grow older (Spanbroek 2005).

QoL for RAC residents and patients in general has been the subject of many studies and papers written predominantly from a care perspective (Willhelmson 2005) and while there is a strong relationship between QoL and care (Parker 2004) the World Health Organisation Quality of Life Group notes QoL as being multidimensional and therefore difficult to define (Barnes 2002, Bowling 2007). This ill defined multidimensional term therefore has other factors, aside from care, to explore and one aspect could be the effect of environmental design.

QoL for residents is a primary aim in RAC facilities and care is an essential part of realising that aim. RAC facilities are also work places for carers and those other than residents and visitors and as such literature indicates that workplaces can cause stress (Marchand 2002, Parslow 2004, Wellens 2006). Environments can have an effect on stress (Clark 2007, Wilhelm 2004, Aspinall 2001, Vischer 2007, Moultrie 2007, Stokols 2002) and in the context of a RAC facility the level of stress can have an effect on care (Hannan 2001, Edvardsson 2005) which is a factor of QoL (Willhelmson 2005, Parker 2004) and a primary aim of RAC facilities. Therefore it would seem reasonable to put forward the question "will the consideration of workplace stress in environmental design affect quality of life in RAC?"

WORKPLACE STRESS

Prior to the 1970's stress was viewed as a simple mechanical response to a threat, this view has been broadened to accept that stress is non specific and is based on an individual's conscious or unconscious evaluation of an event (Lazarus and Folkman 1984). Whereas stress is not necessarily negative, continued exposure may alter the body's sensitivity to the hormone cortisol resulting in varying effects dependent on the individual (Olofsson, Bengtsson et al. 2003).

The workplace environment can be a contributor to stress by providing stressors to which an individual reacts (Lloyd, King et al. 2002). Since stress is an individual reaction (Kinman and Jones 2005) there can be a varying impact on physical and mental health (Parslow, Jorm et al. 2004). Job stress can contribute to stress-related illnesses, such as mental, behavioral, and cardiovascular diseases (Toppinen-Tanner, Ojajärvi et al. 2005), can lead to staff turnover (Ellenbecker 2003; Coogle, Parham et al. 2007), loss of production and absenteeism (Parslow, Jorm et al. 2004; Kinman and Jones 2005; Marchand, Demers et al. 2005; Toppinen-Tanner, Ojajärvi et al. 2005). The Australian Bureau of Statistics report that in 2005-06 "exposure to mental stress" accounted for 5% of all work related injuries making it the fifth most common category of work related injury (Australian Bureau of Statistics 2006). Not all work related stress is a result of high levels of personal work related responsibility with some other causes including being the victim of sexual or racial harassment or exposure to a traumatic event (Australian Bureau of Statistics 2006). Work related injuries that resulted in the largest periods away from work included stress which accounted for 51% of people taking time of work for more than five days (Australian Bureau of Statistics 2007). The Australian Bureau of Statistics estimates that the total cost of work related injury in 2005-06 was $34.96 billion AUD (Australian Bureau of Statistics 2006) of which a minimum of 5% could be the result of stress (minimum as stress represented 5% of the work related injuries but resulted in longer durations away from work).

The "health and community services" industry comprised 1,038,000 people in 2005-06 which represented 10.4% of the Australian workforce however this industry had a disproportional representation of 11.5% of all reported work related injuries which made it the industry with the third most work related injuries behind the retail and manufacturing industries and puts it marginally ahead of the construction industry which had 11% of reported work related injuries (but makes up 8.8% of the work place) (Australian Bureau of Statistics 2006).

The Australian Bureau of Statistics information on stress in the workplace is echoed throughout the world. Studies in Canada showed that 42.9% of workers had reported at least one instance of psychological distress (Marchand, Demers et al. 2005) a result that was similar to studies from North America (Brodaty, Draper et al. 2003; Coogle, Parham et al. 2007) and Europe (Olofsson, Bengtsson et al. 2003; Harenstam 2005; Marchand, Demers et al. 2005; Nordam, Torjuul et al. 2005; Toppinen-Tanner, Ojajärvi et al. 2005).

There is evidence that the incidence of stress in the workplace is increasing however one argument is that the inherent non specific nature of work place stress, the lack of definition and the reliance on an individual's perception results in a flexible concept that can be used to substantiate a variety of situations to suit individuals or organisations (Kinman and Jones 2005). This is an idea supported by Schaufeli and Enzmann (1998) who argue that stress related problems are more becoming noticeable as people are better able and more prepared to describe problems in psychosocial terms (Rafnsdottira, Gunnarsdottira et al. 2004).

Despite the reasons for the increased occurrence and/or visibility of workplace stress there are particular stressors imposed by the work environment in residential aged care that may combine to cause stress including shift working conditions (Moniz-Cook, Woods et al. 2000), the emotionally charged nature of dealing with older people (Haggstrom, Skovdahl et al. 2005), working with cognitively impaired residents (Brodaty, Draper et al. 2003), exposure to and dealing with
death and dying (Michie, Ridout et al. 1996), the perception that providing care to older people is not prestigious (Moyle, Skinner et al. 2003), tasks and time constraints, including documentation, preventing the opportunity to relate to residents (Michie, Ridout et al. 1996; Ellenbecker 2003; Moyle, Skinner et al. 2003), lack of clinical supervision which may lead to resident abuse or neglect and the associated ethical issues (Brodaty, Draper et al. 2003) and resident's aggressive or disruptive behaviour (Michie, Ridout et al. 1996; Moniz-Cook, Woods et al. 2000; Brodaty, Draper et al. 2003; Morgan, Stewart et al. 2005; Edvardsson, O.Sandman et al. 2008).

The workplace stresses particular to RAC facilities have been very effectively summarised by Redfern et al as having the potential to result in "burnout" or "rustout" in carers (Redfern, Hannan et al. 2002). "Burnout' is a commonly used term which can result from work stressors but "rustout" in RAC facilities can result from constantly caring for highly dependent and cognitively impaired residents where there is little or no possibility of interpersonal relationships resulting in unrewarding work, low levels of job satisfaction and boredom (Redfern, Hannan et al. 2002). Redfern et al associate the causes of "burnout" to overload and "rustout" to underload however both result in the same outcomes (Redfern, Hannan et al. 2002).

EFFECT OF STRESS ON QUALITY OF CARE

There is increasing demand for improvements in the quality of care and better quality of life for residents in RAC, there is also substantial research in the area of job stress for carers in RAC facilities whilst there is also considerable research into QoL for residents. There is also a mounting body of evidence that there is an association between the level of job strain or job satisfaction experienced by carers, the level of care and the QoL of residents in RAC facilities. Edvardsson, Sandman et al undertook a study of 40 residential care units for people with dementia and came to the conclusion that "the well-being of nursing staff is associated with the well-being of people with dementia in residential care settings" (Edvardsson, O.Sandman et al. 2008). In 2001 Hannan, Norman et al conducted a review of the current literature revealing 417 papers relating in some way to stress/satisfaction, care and long term care facilities (not necessarily RAC) of these they cite a total of ten references which relate in some way to the relationship between stress/ satisfaction, quality of care and resident well being (Hannan, Norman et al. 2001). Two of the studies cited by Hannan, Norman et al investigated positive outcomes of the stress/care relationship but the majority investigated the negative relationship (Hannan, Norman et al. 2001). Regardless of the outcomes of the studies the link between work stress/satisfaction, quality of care and resident well being has been identified.

It has been estimated that carers provide 80% to 90% of resident care and are thus the "linchpin" to the provision of quality care (Proctor, Stratton-Powell et al. 1998; Castle 2007). The association between job stress/satisfaction and positive or negative work behaviour like tardiness, poor work performance, absenteeism, tension, irritability or fatigue is therefore important to address in a cohort with the extent of interface and the affect on resident's quality of life afforded to carers. These negative reactions to stress can have a deleterious affect on the quality of care (Proctor, Stratton-Powell et al. 1998). In a study of 1579 responses from carers in 72 facilities over six states in the U.S. by Castle in 2007 carers rated the effect they had on resident's lives as an average 8.2 out of a scale up to 10 (Castle 2007) the importance of the relationship between stress and the quality of care (Redfern, Hannan et al. 2002; Murphy 2007) is therefore essential to providing the level of care anticipated and necessary to promote sustainability in this sector of society.

Although there is a body of literature linking job stress/work satisfaction to levels of care in various types of care facility some authors question the relationship (Gravlin 1994, Goodell & Coeling 1994, Powers et al, 1994, Shepherd et al. 1995, Jenkins & Allen 1998 are cited by Redfern, Hannan et al 2002 page 513). However a possible explanation to a potentially lower level of correlation between work stress and quality of care and lower than anticipated levels of staff burnout found in a relatively small number of studies of RAC facilities is that a large proportion staff leave when exposed to stress (Train, Nurock et al. 2005). In 2002 Redfern, Hannan et al conducted a small study in a RAC facility in London to test the association between job stress/work satisfaction and quality of care and found adequate correlations to warrant further investigation (Redfern, Hannan et al. 2002).

EFFECT OF THE ENVIRONMENT ON STRESS

There is increasing evidence that the physical environment, in which people work, affects both job performance and job satisfaction (Vischer 2007) there is also a link between the physical environment and mental health (Clark, Myron et al. 2007). The physical environment provides a large number of factors or potential stressors (Aspinall 2001) many of these independently pose little risk however exposure to a number or combination of these stressors over a period of time will pose an increased risk (Wellens and Smith 2006). By returning to the work of Lazarus and Folkman (1984) in "Stress, Appraisal and Coping" the effect of this risk is governed by the concept of "an individual's interpretation" which can be affected by an indefinite array of factors and will deter mine their reaction to this risk (Olofsson, Bengtsson et al. 2003).

In 1989 Melamed, Luz et al investigated the factors that can contribute to stress and developed the Ergonomic-Stress-Level (ESL) as a tool to measure aspects of the environment experienced by individuals in their work place (Wellens and Smith 2006) The ESL has been further used in subsequent tests and has showed a relationship between environmental conditions and the occurrence of stress related outcomes (Wellens and Smith 2006). The predictability of the ESL is an indicator and adds further weight to the argument that the environment has an effect on stress.

The built environment is being used in some industries to insulate against stressors and assist in the provision of work outcomes (Stokols, Clitheroe et al. 2002), provide a stimulation for innovation and creativity (Moultrie, Nilsson et al. 2007) and accommodate social relationships (Chan, Beckman et al. 2007). It is also being considered as a part of the holistic approach to work environments (Genaidy, Salem et al. 2007) and is attracting interest as part of the "healing environment" in healthcare (Dijkstra, Pieterse et al. 2006).

Therefore if workplace stress can be affected by the physical environment and workplace stress also affects the level of care which is an important ingredient to the resident's QoL then the design of RAC facilities should consider the insulation of workers from stressors or even the promotion of spaces that stimulate care. Literature has provided some avenues for further investigation.

CANDIDATE STRESSORS

The causes of stress in the workplace are complex and multifaceted (Wellens and Smith 2006) as is the quality of life of residents (Bowling 1995; Barnes 2002) therefore the existence of a "silver bullet" to alleviate worker's stress and simultaneously improve quality of care thereby having a positive effect on QoL for residents is extremely improbable. However the planning and construction of a RAC facility represents a large investment of resources and if these resources can be better utilised to aid the operation of the facility then a step towards sustainability will have been achieved.

A study of current literature has highlighted some candidates for further investigation to determine if modifications to the physical environment can contribute to a reduction of stress in the RAC workplace. These identified candidates have formed the core of a study involving RAC carers being presently undertaken to determine the potential or validity of modifications to the physical environment of a RAC facility that may enhance sustainability.

Aggressive or disruptive behaviour

Amongst the most disturbing and distressing behaviours in RAC is aggressive, disruptive or assaultive behaviour (AB) which does not necessarily need to be directed at a particular carer to be an effective work place stressor (Landreville, B ´edard et al. 2006). AB in a RAC facility can generally be associated with a part of the wide range of changes to behaviour associated with dementia and is commonly described as the "behavioral and psychological symptoms of dementia" or BPSD (Lovheim, Sandman et al. 2006) It is reported that the most common medical condition in Australian RAC facilities is Alzheimer's disease and other dementia with 32% of residents affected. A further 10% of residents are affected by other behavioural disorders resulting in a total of 42% of residents (Australian Bureau of Statistics 2006) having the potential to exhibit AB.

AB has been described by Landreville, B'edard et al as including "…hitting, kicking, scratching, pushing, biting, punching, grabbing, throwing objects, slugging, pinching, cutting, stabbing, spitting, cursing, swearing, insulting, obscene or profane language, sexual aggression, and sexual advances." (Landreville, B´edard et al. 2006). AB has also been described as behaviours that may have a detrimental effect on the resident/carer relationship and may lead to the use of pharmacological or physical restraints (Moniz-Cook, Woods et al. 2000; Morgan, Stewart et al. 2005) even though restraints are often used to protect the resident exhibiting AB from harm rather than to protect the staff (Moore and Haralambous 2007).

Pharmacological treatment of AB, often with atypical antipsychotic drugs, is relatively common despite the associated side affects including the increased risk of stroke or transitory ischemic attack and an increased mortality rate (Lovheim, Sandman et al. 2006). There are also concerns about the quality of life of residents subjected to such pharmacological restraint (Lovheim, Sandman et al. 2006) and the emotional burden on the care giver brought about by this ethical dilemma which provides another work place stressor (Nordam, Torjuul et al. 2005).

AB is most commonly directed at carers as they have the greatest interface and spend the most time with residents and are most often perceived by the resident as invading personal space whilst undertaking their care responsibilities (Morgan, Stewart et al. 2005).

The actual number of assaults or extent of AB is somewhat confused as some authors cite estimates of 9.3 assaults per carer each month to almost daily assaults (Morgan, Stewart et al. 2005; Landreville, B´edard et al. 2006). Morgan, Stewart et al conducted a study in 2004 involving 355 carers and found that 64.5% of those working in special care units and 74.4% of those in non special care units had been physically assaulted by residents in the previous twelve months (Morgan, Stewart et al. 2005).

The worst outcomes of AB are job stress, time off work, staff burnout, staff turnover (Morgan, Stewart et al. 2005) distress, emotional exhaustion and injuries (Landreville, B´edard et al. 2006). A study of 40 facilities in Sweden in 2007 found a correlation between staff stress and the occurrence of AB with facilities where the staff reported a higher level of stress also demonstrated a higher level of AB with the converse also occurring (Edvardsson, O.Sandman et al. 2008). The same study also indicated that facilities where staff reported a more positive caring climate had a lesser occurrence of AB (Edvardsson, O.Sandman et al. 2008). However job strain/stress is not necessarily the inevitable outcome of AB, a study of 253 staff in 12 RAC facilities in Sydney found that although AB was nominated as the attribute most difficult to cope with the staff in different facilities reported varying levels of job strain not necessarily correlated to the levels of AB. A result which suggests that other factors were involved as in some facilities the occurrence of AB was of comparable levels but staff in those facilities reported varying levels of stress with staff in some facilities more able to cope (Brodaty, Draper et al. 2003). This increased ability to cope can be attributed to a large variety of factors including staff training, selection of staff with greater tolerance to AB and provision of a Special Care Unit (SCU) (Morgan, Stewart et al. 2005).

Several authors refer to "adjustments" or "modifications" to the physical environment to cope with AB and one study by Cohen-Mansfield and Werner in 1998 adjusted "visual, auditory and olfactory stimuli" in parts of a facility to replicate a home scene and also a nature scene. There was a decrease in physical assaults in the home scene but no change in verbal AB in either (Landreville, B ´edard et al. 2006).

Adaptations and modifications incorporated into the physical environment have lead to the SCU which is being continually developed to suit residents with BPSD. The complex and changing physical environment of the SCU (Grant and Sommers 1998; Morgan, Stewart et al. 2005; Filan and Llewellyn-Jones 2006; Landreville, B ´edard et al. 2006) warrants further investigation to determine if there are characteristics with a positive effect on carer stress that could be generalised to the benefit of all care staff.

Training

It has been estimated that carers provide 80% to 90% of resident care but are often poorly trained to help them cope with the stresses particular to RAC facilities (Proctor, Stratton-Powell et al. 1998). It has been shown that adequate training can reduce problems with residents (Kotynia-English, McGowan et al. 2005), reduce carer stress (Proctor, Stratton-Powell et al. 1998), improve the attitudes of staff, promote caring behaviours and impact on resident quality of life (Brodaty, Draper et al. 2003).

The growing prevalence of dementia is becoming the most expensive mental health item in Australia with a cost of $3.2billion in 2002 and an anticipated cost double that by 2010 (Access Economics 2003). Despite this, training for dementia specific care of these highly cognitively impaired residents is not mandatory.

Training carers to manage and prevent intrusions into the personal space of those with BPSD has been found to reduce the occurrence of AB (Landreville, B´edard et al. 2006). Landreville, B´edard et al reported on ten studies they had identified from literature where training programmes to assist carers to manage AB had been evaluated. Eight of the ten studies noted that the effects of the training had been positive and showed a reduction in AB with four studies reporting an improvement in resident behaviour (Landreville, B´edard et al. 2006).

Staff training can also be linked to the use of restraints as without adequate training there can be uncertainty over any available alternatives to physical or pharmacological solutions to address the fear of AB or concern over residents falling and harming themselves (Moore and Haralambous 2007).

Staff training in RAC facilities can have an immediate and noticeable effect on attitudes, stress, AB, in particular the frequency of assault (Morgan, Stewart et al. 2005) but can be non permanent if there is a high turnover of staff (Kotynia-English, McGowan et al. 2005).

In a study of 2,015 residents over 59 RAC facilities in Maryland, U.S. the authors adopted outcome indicators like theoretically preventable infections and hospitalisations as a measure of quality of care in RAC. Amongst the findings of the study it was noted that there may have been up to 40% of the hospitalisations resulting from infections that were "inappropriate" and could have been avoided as the resident could have been suitably cared for at the RAC facility had there been better staff training (Zimmerman, Gruber-Baldini et al. 2002). Additionally the study found that staff turnover, which can be symptom of work stress (Michie, Ridout et al. 1996; Brodaty, Draper et al. 2003; Morgan, Stewart et al. 2005; Toppinen-Tanner, Ojajärvi et al. 2005; Coogle, Parham et al. 2007) was a common factor in both infection and hospitalisation and was linked to a reduction in familiarity between resident and staff and inconstant levels of training and supervision (Zimmerman, Gruber-Baldini et al. 2002). Reducing the financial burden and resources utilised in unnecessary and avoidable infections and hospitalisation would greatly aid sustainability.

As the incidence of BPSD increases in RAC facilities the nature and focus of training will have to adjust (Morgan, Stewart et al. 2005) to meet the challenge aligned with an ongoing regular training support programme which should improve morale and reduce carer stress (Proctor, Stratton-Powell et al. 1998). To accommodate an ongoing training programme the effects of incorporating a dedicated training facility within the RAC facilities and the type of training facility need to be further investigated.

Residents with high risk of falls

Frail, cognitively impaired residents in RAC facilities are of concern to the community as they present a great risk of falling and the resultant serious consequences (Jensen, Nyberg et al. 2003). Falls were one of the major causes of hospitalisation in older people in New South Wales ahead of circulatory, digestive conditions and cancers in 2004 (Australian Bureau of Statistics 2004).

Falls and the consequences are a considerable cost to the community with the costs of falls in older people representing approximately 33% of the cost of medical treatment for all injuries in Sweden (Kallin, Jensen et al. 2004). It is possible that some falls may be preventable and this cost and utilisation of resources could be reduced (Jensen, Nyberg et al. 2003; Kallin, Jensen et al. 2004).

The causes of falls in RAC has been the subject of several studies with many falls being multifactorial and affected by a combination of factors relating to the predisposition of the resident, the level of care and the environment (Kallin, Jensen et al. 2004). A study in Sweden of 199 residents over a period of 12 months recorded 482 falls of which 331 could be attributed to causes or principal causes. These causes included the effects of disease, drug side effects, problems walking, reaction times, previous falls, poor vision and external factors (Kallin, Jensen et al. 2004). External factors alone were the primary contributing factor to 7.9% or 38 of the recorded falls, these factors included obstacles, defective equipment, clothes and building problems however there were other falls where external factors were in combination with primary factors like disease and drug side effects (Kallin, Jensen et al. 2004).

The risk of falls can have the effect of a stressor on staff as carers are concerned that they cannot constantly watch every resident in their care (Haggstrom, Skovdahl et al. 2005; Nordam, Torjuul et al. 2005; Bauer 2006) who is at risk of falling. Staff often opt to protect the resident at greater risk by pharmacological or physical restraint on the basis that the potential harm without the restraint is greater than the inherent risk of the restraint (Moore and Haralambous 2007). A number facilities have physical environments with characteristics that make it difficult to avoid restraints like single bedrooms with limited vision of residents in ensuites, furniture, residents' personal belongings (Moore and Haralambous 2007) and equipment which contribute to the risk of falls and can increase the perceived need for restraint (Moore and Haralambous 2007).

A wide range of environmental modifications to reduce the risk of falls have been utilized and trialed. These modifications include rearranging furniture, securing floor coverings, alleviating steps, providing grab rails and hand rails, improved lighting (Jensen, Nyberg et al. 2003), specifically designed beds with bedrails (Kallin, Jensen et al. 2004) and securing resident's personal belongings to avoid clutter (Moore and Haralambous 2007).

The range of environmental modifications requires further investigation as it is extensive and could range from very subtle changes to lighting or decoration to more extensive building alterations. Potential modifications may also be contentious with ethical dimensions, by way of example, Kallin, Jensen et al (2004) see bed rails as a means of avoiding unnecessary falls, Moore & Haralambous (2007) note that they are a form of restraint.

Further investigation is required to identify and analyse the range of potential modifications with ability to reduce the risks of avoidable falls, the inherent stress on care staff, the detrimental effects on residents and family and the cost to the overall community.

Relatives

The relationship between relatives and care staff in RAC facilities has been shown to be a significant source of work stress in some instances as family members relay their expectations for their relative to staff. These expectations may not necessarily be those of the resident as expectancy disconfirmation may apply if the resident has no expectation they may be satisfied with any level of service (Chong 2003). Similarly some of the expectations expressed by the "Baby Boomer" children may not be those of the "Veteran" parent now in RAC, "Baby Boomer" expectations are shown to be much greater than those of their parents (Maples and Abney 2006). Some care staff have expressed difficulty in dealing with relatives of residents (Michie, Ridout et al. 1996). The sources of the family member's concern can be a result of many factors including anguish that the care of the resident has passed to another party, anticipation by family members of the resident's expectations, concerns over the level of care (Train, Nurock et al. 2005), lack of information (Brodaty, Draper et al. 2003) and the feeling that participation of relatives in an essential ingredient to quality of care (Bauer 2006).

Relatives may feel ongoing anguish that they have passed care of a family member to others and although they may not object to the level of care in the facility they may be experiencing part of the grieving process (Train, Nurock et al. 2005). In this situation they may project their family member's anticipated expectations based on their relationship with the resident, recollections of the resident's previous quality of life and their own personality onto the care environment (Train, Nurock et al. 2005). Relative's dissatisfaction may also, largely through lack of communication, see the routine nature of care as unsympathetic with the potential to fail to recognise the unique needs of the resident (Bauer 2006). This dissatisfaction has lead in some cases to verbal conflict with care staff (Bauer 2006) which could be a work place stressor with a similar result to resident's AB. To further complicate the family/care staff relationship Bauer notes that some families may experience dissatisfaction but be reluctant to complain for fear or retaliation against the resident (Bauer 2006).

Some family interaction may provide stressors to care staff in that relative's concern, beliefs and demands in some areas result in actions that care staff may see as unnecessary and with which they are not entirely comfortable. An example would be repeated requests for some form of restraint or obstructing the reduction of restraints where the family believe there may be a chance of saving the resident from the risk of falling (Moore and Haralambous 2007).

However family involvement, interaction and contribution is known to be an important factor in the well-being of residents in RAC and good care in a sustainable facility would accommodate the needs of all stakeholders (Bauer 2006). In Australia, the significance of the family has been included in both the Charter of Residents' Rights and Responsibilities (Commonwealth Department of Health and Aged Care 2002) and the Australian Government aged care standards of practice (Commonwealth Department of Health and Aged Care 2001)

Many relatives have difficulty imagining their own ageing process and growing dependency and are not able to identify with the resident's needs however, in the context of their current lives, most people to not want to envisage ending up in RAC (Train, Nurock et al. 2005). It would seem that adequate communication is essential to inform relatives of the processes and options available and to thereby go some way to reduce stress on care staff (Train, Nurock et al. 2005; Moore and Haralambous 2007).

Family involvement can be a stressor to care staff however adequate communication could alleviate some stress. The area of family involvement and communication requires further investigation to determine any implications where the physical environment may assist communication and have an effect on care staff stress.

Privacy, Dignity and Autonomy

Privacy, dignity and autonomy are essential for both residents and care staff in RAC facilities. Bowling and Gabriel (2007) argue that control, independence and autonomy are base human needs that are essential for individuals and not culture dependent (Bowling and Gabriel 2007). Privacy, autonomy, safety and personalization are often considered to relate to quality of life for residents (Slaughter, Calkins et al. 2006) in the RAC context but these factors are not always considered when care staff are concerned.

Care work in RAC is described by Chong (2003) as a "closed system" where residents receive "a monopolistic service system where choice, autonomy and participation are out of their control" (Chong 2003). The service is very personal, intimate and around-the-clock with no break (Chong 2003) for the resident or their carers. The lack of privacy and autonomy for care staff along with continuing stress at work can cause excessive job strain which can result in alienation and a lack of belonging which can result in exhaustion and irritability which in combination can be labeled staff burnout (Nordam, Torjuul et al. 2005).

However the effects privacy and autonomy can have on job satisfaction are significant (Moyle, Skinner et al. 2003) and care staff with higher job satisfaction have been found to be more inclined to have better resident /carer relationships, pass on information during care tasks and offer residents more personal attention and choice (Jenkins and Allen 1998).

Due to the intimate and constant nature of care work some literature has mentioned that care staff may need privacy, possibly in the form of separate areas away from residents, for break times and meetings (Zimmerman, Gruber-Baldini et al. 2002).

The core aim for most RAC facilities is to increase the quality of life for residents with some of the key factors being dignity, which encompasses privacy, and autonomy (Train, Nurock et al. 2005). A view of autonomy in RAC is self governance, independence and self determination giving residents the ability to choose for themselves (Tuckett 2005) this requires the promotion of resident's unique identity and treatment as a dignified human being. Care without dignity becomes disengaged and converts the care of humans to a technical process which can have an undesired and counter productive effect on both resident and carer in making them feel powerless and become a stressor due to ethical dilemma (Nordam, Torjuul et al. 2005; Tuckett 2005).

The challenge for RAC facilities is to create an environment that has the ability to provide residents with flexibility and choice (Train, Nurock et al. 2005) adequate privacy to allow intimacy, meeting and dining with visitors (Zimmerman, Gruber-

Baldini et al. 2002) and as much autonomy and control as possible provided it does not jeopardise their safety (Calkins and Marsden 2000).

Privacy, dignity and autonomy are essential for both care staff and residents and can have a multi faceted influence on carer stress. Further investigation is needed to determine if the physical environment can enhance the ability for a RAC facility to provide privacy, dignity and autonomy for both residents and care staff.

Meals

Mealtimes can be stressful periods in RAC facilities where care staff can be faced with the responsibility and difficulties of ensuring adequate nutrition and hydration for residents with varying levels of cognition including the inability to transfer food to the mouth, high risk of choking, diminished senses of taste and smell, loss of appetite and resistive behaviour with refusal to eat (Crack 2007). Nutrition and hydration are however critical factors of successful ageing and quality of life with the dining experience contributing to social and physiological quality of life (Ruigrok and Sheridan 2006).

Despite the complexities and variety of potential stressors involved with meal management and ensuring adequate nutrition and hydration for dependent residents (Crack 2007), the community has an expectation that RAC facilities provide a home like environment particularly around dining areas. This is not an entirely realistic expectation as RAC facilities provide a mixture of home and institutional environments at meal time. A relevant example is provided by Slaughter, Calkins et al. (2006) who explain that people at home prepare meals, where at a resort the meals are prepared and served by others but in a hospital care staff carefully monitor nutrition, provide assistance and administer medication (Slaughter, Calkins et al. 2006).The RAC facility can only provide a mix of these scenarios in an environment with some “home like” décor. Therefore the physical environment is an essential ingredient to providing the home like atmosphere expected by the community and it must be used in conjunction with the other activities of food service and care, to provide the dining setting that feels as much like home as possible (Calkins and Marsden 2000).

Aesthetics

Aesthetics are seen by some as essentially private and highly subjective therefore difficult to measure and therefore a difficult subject for a rational study (Aspinall 2001). However aesthetics do play a part in everyday life and most people appreciate the benefits of beauty in the surroundings (Edvardsson, Sandman et al. 2005) or the experience of being in a pleasant space (Danes 2002). The aesthetics of RAC facilities may become more prevalent as Baby Boomers age and enter RAC (Maples and Abney 2006) as they are more conscious of quality and beauty and have higher expectations than their parents, the Veterans (Quine and Carter 2006).

The health and well being of humans is influenced by the environment particularly in caring environments (Edvardsson, Sandman et al. 2005) where studies have found that both care staff and residents have identified that they need environments that are safe, private, friendly and 'homely' (Murphy 2007)

Although care staff and residents have both identified the environment of a RAC facility as important they look at different aspects. In a Swedish study between 2001 and 2004 of 112 care staff, residents and relatives the care staff indicated that significant factors to job satisfaction were the aesthetics of the surroundings in conjunction with "the spirit of the workforce" (Edvardsson 2008). In the same study residents and relatives looked more to feelings of security and safety (Edvardsson 2008).

Noise

RAC facilities can sometimes be noisy places particularly when residents with BPSD may be engaging in noisy vocalisations, disruptive or aggressive behaviour. Noise in the work environment, particularly noise over which a person has no control, can lead to job stress (Hughes 2001; Wellens and Smith 2006; Vischer 2007) and in the case of loud cries and laments from other humans some care staff can feel that the noise can signal angst (McLean 2006) and this in itself can be a stressor. Noise can also come from activities, equipment and nurse call systems (Slaughter, Calkins et al. 2006) but can also be a trigger for AB (Landreville, B ´edard et al. 2006) possibly because studies in cognitive psychology have shown that noise can be a stressor/distractor that cannot be filtered out (Hughes 2001).

Others

There are other aspects of the RAC facility that have the potential to be modified or adapted to reduce stress.

Animal-assisted therapy (AAT) has been the subject of several studies where it has been shown to be beneficial particularly in reducing AB and the resultant stress in both residents and care staff and is becoming more popular as a therapy in RAC facilities (Filan and Llewellyn-Jones 2006). Further investigation is required to identify modifications and adaptations to the physical environment of RAC facilities to accommodate AAT.

The effects of music are also the subject of studies with some results indicating that there can be a contribution to well being and a reduction of stress as music has the ability to link the past with the present (Hays and Minichiello 2005).

FURTHER INVESTIGATION AND CURRENT STUDY

The proposal that social sustainability can be enhanced and quality of life improved for residents in RAC via modifications and adaptations to the physical environment with the aim of reducing stressors applicable to carers is based upon theory and requires further investigation.

Presently a study is being undertaken to determine the extent to which the candidate environmental stressors are experienced by those working in the RAC sector, and whether further environmental stressors are experienced beyond those already identified in the literature. This study addresses multiple perspectives (practitioners and managers), using multiple methods (Delphi study and semi-structured interviews), and is national in scope.

CONCLUSION

This paper has demonstrated that there is a strong relationship between QoL and care, but that QoL is complex, multidimensional, and therefore difficult to define. It has further argued that there are other factors that can affect care and QoL.

The RAC workplace environment can provide particular stressors to which individuals have their own varying reactions, thereby determining their individual levels of stress/satisfaction. There is an association between quality of care and work stress/job satisfaction however with much of the actual care being undertaken by carers (as distinct from registered nurses) their levels of job stress/ satisfaction have the potential to have a great affect on quality of care.

The physical environment affects both job performance and job satisfaction by introducing or alleviating potential stressors. Therefore if workplace stress can be affected by the physical environment and workplace stress also affects the level of care which is a part of QoL then RAC facilities may find an advantage in insulating carers from stressors.

A range of design attributes with the potential to impact upon carer stress have been outlined and there is further investigation required in these areas. A pilot study intended to confirm/extend this model has been described.

REFERENCES

Access Economics (2003). The Dementia Epidemic: Economic Impact and Positive Solutions for Australia. Canberra, Alzheimer's Australia**:** 1-109.

Aspinall, P. (2001). "Building Behaviour." Building Services Engineering Research & Technology **22**(1): 34-46.

Australian Bureau of Statistics (2004). Older People, New South Wales. A. a. H. C. D. NSW Department of Disability. Canberra, Australian Bureau of Statistics.

Australian Bureau of Statistics (2006). Australian Social Trends 2006. Canberra, Australian Bureau of Statistics.

Australian Bureau of Statistics (2006). Work-Related Injuries 2006. Canberra, Australian Bureau of Statistics.

Australian Bureau of Statistics (2007). Australian Social Trends 2007. Canberra, Australian Bureau of Statistics.

Australian Bureau of Statistics, A. (2004). Older People, New South Wales. A. a. H. C. D. NSW Department of Disability. Canberra, Australian Bureau of Statistics.

Australian Bureau of Statistics, A. (2006). Australian Social Trends 2006. Canberra, Australian Bureau of Statistics.

Australian Government Department of Health and Ageing (2006). Building Quality for Residential Care Services - Certification.

Barnes, S. (2002). "The design of caring environments and the quality of life of older people." Ageing & Society(22): 775-789.

Basiago, A. (1999). "Economic, social and environmental sustainability in development theory and urban planning practice." The Environmentalist **19**: 145-161.

Bauer, M. (2006). "Collaboration and control: nurses' constructions of the role of family in nursing home care." Journal of Advanced Nursing **54**(1): 45-52.

Bender, A. D. (2004). "The Coming of the Baby Boomers: Implications for the Pharmaceutical Industry." Generations(Winter 2004/2005): 26 - 31.

Birrell, B. and Healy, E. (2005). "Baby Boomer Affluence - Myth or Reality?" Just Policy(37): 33-40.

Bowling, A. (1995). "What things are important in peoples lives? A survey of the public's judgements to inform scales of health related quality of life." Social Science & Medicine **41**(10): 1447-1462.

Bowling, A. and Gabriel, Z. (2007). "Lay theories of quality of life in older age." Ageing & Society **27**: 827 - 848.

Brodaty, H., Draper, B. and Low, L.-F. (2003). "Nursing home staff attitudes towards residents with dementia: strain and satisfaction with work." Journal of Advanced Nursing **44**(6): 583-590.

Calkins, M. P. and Marsden, J. P. (2000). "Home Is Where the Heart Is: Designing To Recreate Home." Alzheimer's Care Quarterly **1**(1): 8-16.

Castle, N. (2007). "Assessing Job Satisfaction of Nurse Aides in Nursing Homes." Journal of Gerontological Nursing **33**(5): 41-47.

Chan, J. K., Beckman, S. L. and Lawrence, P. G. (2007). "Workplace Design: A New Managerial Imperative." California Management Review **49**(2): 6-22.

Chong, A. (2003). "Validating the accuracy of the resident satisfaction measure." Journal of Cross-Cultural Gerontology **18**: 203-226.

Clark, C., Myron, R., Stansfeld, S. A. and Candy, B. (2007). "A systematic review of the evidence on the effect of the built and physical environment on mental health." Journal of Public Mental Health **6**(2): 14-27.

Coogle, C. L., Parham, I. A., Jablonski, R. and Rachel, J. A. (2007). "Enhanced Care Assistant Training to Address the Workforce Crisis in Home Care: Changes Related to Job Satisfaction and Career Commitment." Care Management Journal **8**(2): 71-79.

Coombs, G. and Dollery, B. (2004). "The Ageing of Australia: Fiscal Sustainability, Intergenerational Equity and Inter-temporal Fiscal Balance." Australian Journal of Social Issues **39**(4): 459 - 470.

Crack, J. (2007). "Promoting quality care for older people in meal management: whose responsibility is it?" Australian Journal of Advanced Nursing **25**(1): 85-89.

Danes, S. (2002). "Creating an Environment for Community." Alzheimer's Care Quarterly **3**(1): 61-66.

Dijkstra, K., Pieterse, M. and Pruyn, A. (2006). "Physical environmental stimuli that turn healthcare facilities into healing environments through psychologically mediated effects: systematic review." Journal of Advanced Nursing **56**(2): 166-181.

Eden, S. (2000). "Environmental issues: sustainable progress?" Progress in Human Geography **24**(1): 111-118.

Edvardsson, D. (2008). "Therapeutic Environments for Older Adults: Constituents and Meanings." Journal of Gerontological Nursing **34**(6).

Edvardsson, D., O.Sandman, P., Nay, R. and Karlsson, S. (2008). "Associations between the working characteristics of nursing staff and the prevalence of behavioral symptoms in people with dementia in residential care." International Psychogeriatrics **20**(4): 764-776.

Edvardsson, D., Sandman, P.-O. and Rasmussen, B. H. (2005). "Sensing an atmosphere of ease: a tentative theory of supportive care settings." Scandinavian Journal of Caring Sciences **19**(4): 344-353.

Ellenbecker, C. H. (2003). "A theoretical model of job retention for home health care nurses." Journal of Advanced Nursing **47**(3): 303-310.

Filan, S. L. and Llewellyn-Jones, R. H. (2006). "Animal-assisted therapy for dementia: a review of the literature." International Psychogeriatrics **18**(4): 597-611.

Genaidy, A., Salem, S., Karwowski, W., Paez, O. and Tuncel, S. (2007). "The work compatibility improvement framework: an integrated perspective of the human-at-work system." Ergonomics **50**(1): 3-25.

Ginsburg, M., Citko, J., Cadogan, M. and Hill, T. E. (2005). "Improving End-of-Life Care in Nursing Facilities: The Community State Partnership to Improve End-of-Life Care - California." Journal of Palliative Medicine **8**(2): 300 - 312.

Grant, L. A. and Sommers, A. R. (1998). "Adapting living environments for persons with Alzheimer's disease." Geriatrics **53**(Supplement 1): S61-S65.

Haggstrom, E., Skovdahl, K., Flackman, B., Kihlgren, A. L. and Kihlgren, M. (2005). "Work satisfaction and dissatisfaction – caregivers' experiences after a two-year intervention in a newly opened nursing home." Journal of Clinical Nursing **14**: 9-19.

Hannan, S., Norman, I. J. and Redfern, S. J. (2001). "Care work and quality of care for older people: a review of the research literature." Reviews in Clinical Gerontology **11**: 189-203.

Harenstam, A. (2005). "Different development trends in working life and increasing occupational stress require new work environment strategies." Work **24**: 261-277.

Hays, T. and Minichiello, V. (2005). "The contribution of music to quality of life in older people: an Australian qualitative study." Ageing & Society **25**: 261-278.

Healy, J., Sharman, E. and Lokuge, B. (2006). "Australia Health System Review." Health Care Systems in Transition 2006 **8**(5): 1-158.

Howe, A. and Healy, J. (2005). "Generational Justice in Aged Care Policy in Australia and the United Kingdom." Australasian Journal on Ageing **24**(June 2005): S12-S18.

Howe, A. L. (2003). Housing an Older Australia: More of the Same or Something Different. Housing Futures in an Ageing Australia, Melbourne, AHURI (Australian Housing and Urban Research Institute).

Hughes, B. M. (2001). "Psychology, hospitalization and some thoughts on medical training." The European Journal of Psychotherapy, Counselling & Health **4**(1): 7-26.

Jenkins, H. and Allen, C. (1998). "The relationship between staff Burnout/distress and interactions with residents in two residential homes for older people." International Journal of Geriatric Psychiatry **13**: 466-472.

Jensen, J., Nyberg, L., Gustafson, Y. and Lundin-Olsson, L. (2003). "Fall and Injury Prevention in Residential Care: Effects in Residents with Higher and Lower Levels of Cognition." Journal of the American Geriatrics Society **51**: 627-635.

Kallin, K., Jensen, J., Olsson, L. L., Nyberg, L. and Gustafson, Y. (2004). "Why the Elderly Fall in Residential Care Facilities, and Suggested Remedies." The Journal of Family Practice **53**(1): 41 - 52.

Kinman, G. and Jones, F. (2005). "Lay representations of workplace stress: What do people really mean when they say they are stressed?" Work & Stress **19**(2): 101-120.

Kotynia-English, R., McGowan, H. and Almeida, O. P. (2005). "A randomized trial of early psychiatric intervention in residential care: impact on health outcomes." International Psychogeriatrics **17**(3): 475-485.

Landreville, P., B´edard, A., Verreault, R. e., Desrosiers, J., Champoux, N., Monette, J. and Voyer, P. (2006). "Non-pharmacological interventions for aggressive behavior in older adults living in long-term care facilities." International Psychogeriatrics **18**(1): 47-73.

Lazarus, R. S. and Folkman, S. (1984). Stress, Appraisal and Coping, Springer Publishing Company, New York.

Lloyd, C., King, R. and Chenoweth, L. (2002). "Social work, stress and burnout: A review." Journal of Mental Health **11**(3): 255-265.

Lovheim, H., Sandman, P.-O., Kallin, K., Karlsson, S. and Gustafson1, Y. (2006). "Relationship between antipsychotic drug use and behavioral and psychological symptoms of dementia in old people with cognitive impairment living in geriatric care." International Psychogeriatrics **18**(4): 713-726.

Maples, M. F. and Abney, P. C. (2006). "Baby Boomers Mature and Gerontological Counseling Comes of Age." Journal of Counseling and Development **84**(Winter 2006): 3 - 9.

Marchand, A., Demers, A. and Durand, P. (2005). "Do occupation and work conditions really matter? A longitudinal analysis of psychological distress experiences among Canadian workers." Sociology of Health & Illness **27**(5): 602-627.

McLean, A. (2006). "From commodity to community in nursing homes: an impossibility ?" Ageing & Society **26**: 925-937.

Michie, S., Ridout, K. and Johnston, M. (1996). "Stress in nursing and patients' satisfaction with health care." British Journal of Nursing **5**(16): 1002-1006.

Mitchell, W. and Mosler, W. (2006). "Understanding the Economic Fallacies of the Intergenerational Debate." Australian Journal of Social Issues **41**(2): 159 - 170.

Moniz-Cook, E., Woods, R. and Gardiner, E. (2000). "Staff factors associated with perception of behaviour as `challenging' in residential and nursing homes." Aging & Mental Health **4**(1): 48-55.

Moore, K. and Haralambous, B. (2007). "Barriers to reducing the use of restraints in residential elder care facilities." Journal of Advanced Nursing **58**(6): 532-540.

Morgan, D. G., Stewart, N. J., D'Arcy, C., Forbes, D. and Lawson, J. (2005). "Work stress and physical assault of nursing aides in rural nursing homes with and without dementia special care units." Journal of Psychiatric and Mental Health Nursing **12**: 347-358.

Moultrie, J., Nilsson, M., Dissel, M., Haner, U.-E., Janssen, S. and Lugt, R. V. d. (2007). "Innovation Spaces: Towards a Framework for Understanding the Role of the Physical Environment in Innovation." Creativity and Innovation Management **16**(1).

Moyle, W., Skinner, J., Rowe, G. and Gork, C. (2003). "Views of job satisfaction and dissatisfaction in Australian long-term care." Journal of Clinical Nursing **12**: 168-176.

Murphy, K. (2007). "Nurses' perceptions of quality and the factors that affect quality care for older people living in long-term care settings in Ireland." Journal of Clinical Nursing **16**: 873-884.

Nordam, A., Torjuul, K. and Sørlie, V. (2005). "Ethical challenges in the care of older people and risk of being burned out among male nurses." Journal of Clinical Nursing **14**: 1248-1256.

O'Hara, S. U. (1999). "Community based urban development: a strategy for improving social sustainability." International Journal of Social Economics **26**(10/11): 1327.

Olofsson, B., Bengtsson, C. and Brink, E. (2003). "Absence of response: a study of nurses' experience of stress in the workplace." Journal of Nursing Management **11**: 351-358.

Pardasani, M. P. (2004). "Senior Centers: Focal Points of Community Based Services for the Elderly." Activities, Adaption and Aging **28**(4): 27-44.

Parslow, R. A., Jorm, A. F., Christensen, H., Rodgers, B., Strazdins, L. and D'Souza, R. M. (2004). "The associations between work stress and mental health: A comparison of organizationally employed and self-employed workers." Work & Stress **18**(3): 231-244.

Porta, S. and Renne, J. L. (2005). "Linking urban design to sustainability: formal indicators of social urban sustainability field research in Perth, Western Australia." Urban Design International **10**: 51-64.
Proctor, R., Stratton-Powell, H., Tarrier, N. and Burns, A. (1998). "The impact of training and support on stress among care staff in nursing and residential homes for the elderly." Journal of Mental Health **7**(1).
Quine, S. and Carter, S. (2006). "Australian Baby Boomers' Expectations and Plans for Their Old Age." Australasian Journal on Ageing **25**(1): 3-8.
Rafnsdottira, G. L., Gunnarsdottira, H. K. and Tomassona, K. (2004). "Work organization, well-being and health in geriatric care." Work **22**: 49-55.
Redfern, S., Hannan, S., Norman, I. and Martin, F. (2002). "Work satisfaction, stress, quality of care and morale of older people in a nursing home." Health and Social Care in the Community **10**(6): 512-517.
Ruigrok, J. and Sheridan, L. (2006). "Life Enrichment Programme: Enhanced Dining Experience, a Pilot Project." International Journal of Health Care Quality Assurance **19**(5): 420-429.
Slaughter, S., Calkins, M., Eliasziw, M. and Reimer, M. (2006). "Measuring Physical and Social Environments in Nursing Homes for People with Middle- to Late-Stage Dementia." Journal of the American Geriatrics Society **54**: 1443-1441.
Spanbroek, N. (2005). "Design Profession and Ageing in Place." Australasian Journal on Ageing **24**(2): 69-70.
Stokols, D., Clitheroe, C. and Zmuidzinas, M. (2002). "Qualities of Work Environments That Promote Perceived Support for Creativity." Creativity Research Journal **14**(2): 137-147.
Toppinen-Tanner, S., Ojajärvi, A., Väänänen, A., Kalimo, R. and Jäppinen, P. (2005). "Burnout as a Predictor of Medically Certified Sick-Leave Absences and Their Diagnosed Causes." Behavioral Medicine **31**: 18-27.
Train, G. H., Nurock, S. A., Manela, M., Kitchen, G. and Livingston, G. A. (2005). "A qualitative study of the experiences of long-term care for residents with dementia, their relatives and staff." Aging & Mental Health **9**(2): 119-128.
Tuckett, A. (2005). "Residents' rights and nurses' ethics in the Australian nursing home." International Nursing Review **52**: 219-224.
UNFPA (2007). State of World Population 2007: Unleashing the potential of urban growth, United Nations Population Fund.
Vischer, J. C. (2007). "The effects of the physical environment on job performance: towards a theoretical model of workspace stress." Stress and Health **23**: 175-184.
Vladeck, B. (2005). "Economic and Policy Implications of Improving Longevity." Journal of the American Geriatrics Society **53**(9): S304-S307.
Wellens, B. T. and Smith, A. P. (2006). "Combined workplace stressors and their relationship with mood, physiology, and performance." Work & Stress **20**(3): 245-258.
Wiggins, R. D., Higgs, P. F. D., Hyde, M. and Blane, D. B. (2004). "Quality of life in the third age: key predictors of the CASP-19 measure." Ageing & Society **24**: 693-708.

Zimmerman, S., Gruber-Baldini, A. L., Hebel, J. R., Sloane, P. D. and Magaziner, J. (2002). "Nursing Home Facility Risk Factors for Infection and Hospitalization: Importance of Registered Nurse Turnover, Administration, and Social Factors." Journal of the American Geriatrics Society **50**(12): 1987-1995.

Development of a visual whole life-cycle energy assessment framework for built environment

Dr Richard Lord, Prof. Nashwan Dawood, Saad Dawood

University of Teesside, UK

Global warming, climate change, ozone depletion and the escalating costs of fossil fuels over the last few years, are now becoming more challenging and complex than ever and have forced governments and engineers to re-examine the whole approach to the design and control of building energy systems and the whole construction process. As a result, carbon reduction has become a global target and a goal has been set by the UK Government to reduce by 80% UK carbon emissions by the year 2050, (DEFRA, 2004). The UNFCC (United Nations Framework Convention on Climate Change) adopted the Kyoto protocol, establishing legally binding targets for the developed world countries that ratified the protocol. It aims to reduce greenhouse gas emissions by an overall 5% below 1990 levels during the period between 2008 and 2012. Previous literature suggested that the ability to assess designs with a view to reducing their impact with seamless integration with 3D-CAD representations enables design professionals to make informed decisions on the environmental impact of building structures and their running costs.

Our review of current literature and research projects in the area of sustainability, energy and assessment applied to Built Environment identified gaps in current knowledge and tools. There is also a need to integrate sustainability within the whole life cycle (WLC) of a building from design through construction to operation.

This paper aims to give an overall review of the knowledge and technologies in the research area. We present a framework, methodologies and technologies that will facilitate the integration of Environmental Impact Assessment (EIA), Whole Life Cycle Cost Assessment (WLCCA) and Life Cycle Assessment (LCA) using 3D and BIM technologies. This approach will bring together many aspects in order to assess the environmental performance of the whole life cycle of the building at an early design stage and allow key decision-makers to enhance the accuracy of such assessments.

Keywords: building information modelling, energy profile, environmental impact, sustainability

1. Introduction

The paper is part of the research topic "Integration of 3D with Environmental Impact Assessment at the early design stage". The idea of this research is to create a framework and a prototype that integrates 3D/VR models of buildings with Environmental Impact Assessment, Whole Life Costing and Life Cycle Assessment of the building project during the outline design process. Building information models (BIM) and 3D technology will be used to visualise the result and allow better or more accurate decision making for the project stakeholders.

A comprehensive literature review has been undertaken to identify the state-of-the-art of energy assessment software and the data models available to decision-makers, the methodologies to assess environmental impact and current developments. This review has identified significant gaps in current knowledge and tools. For example, the development of a generic data framework would help decision-makers to accurately estimate the sustainability costs and benefits. The Sustainable Urban Environment evaluation of sustainability tools (sue-MoT 2003, sue-MoT 2004) has revealed a number of key issues:

- There is a need to integrate sustainability within the whole life cycle analysis of a building from design through construction to operation. (Mark A. et al.2006).
- We need the use of such tools to become almost synonymous with "green" building.

El-Haram et al. (2005) currently SUE-Mot is working to develop an Integrated Sustainability Assessment Toolkit (ISAT) that brings together many approaches, allowing key decision-makers to identify the most appropriate for their project and to combine the results based on their values. Also many works have been done by other scholars in the field, for example (Ness B. et. al 2007). Reported that "..Efforts have been made through combining two or more different tools to extend the focus of analysis".
Loh E. (2008) by making environmental impact analysis and life cycle cost control readily linked to 3D, the value of 3D technology will be enhanced significantly and it will likely result in more use of the technology in the construction process.

The result showed that the individual assessment method does not offer a total solution. It cannot assess human or environmental safety and does not address comprehensive environmental management, cost and LCA. Hence, the individual assessment method by itself is insufficient for decision-making. Thus, we need to bring together many approaches, allowing key decision-makers to enhance the accuracy of assessment tool results. Also it would provide a vital tool to bridge the design / operating performance gap by providing the feedback loop that is so lacking at present.

2. Sustainability, energy and assessment applied to the Built Environment.

2.1 Sustainability

More than 20 years after the concept of sustainability gained international recognition through the Brundtland Commission (World Commission on Environment and Development, 1987), it continues to arouse much debate about how it should be defined, interpreted and assessed. It has generated a wealth of research and policy discussion on the meaning, measurability and feasibility of sustainable development. Sustainable development can be defined in a number of ways; (Fowke and Prasad 1996) have identified at least 80 different, often competing and sometimes contradictory, definitions. (Parkin S. et al. 2003) report over 200 definitions reflecting the complexity and uncertainty over what is to be sustained, by whom, for whom and what is the most desirable means of achieving it (Agyeman and Evans, 2004). There is a broad consensus that the concept draws together economic, environmental and social objectives with a commonly rehearsed definition

being that from the Brundtland Report, where it is suggested that sustainable development means " development that meets the needs of the present generation without compromising the ability of the future generations to meet their own needs" (WCED, 1987).
According to (Sage 1998) "Sustainable development refers to the fulfillment of human needs through simultaneous socio-economic and technological progress and conservation of earth's natural systems".
The UK Government has defined sustainable development as "ensuring a better quality of life for everyone now and for the future generations to come". Integration of environmental, social and economic issues is still a key challenge for the delivery of sustainable development and likewise for sustainability assessment. The growing sustainability challenges are supported by research-based information, tools and techniques. The UK Strategy for Sustainable Development (DEFRA, 2005) identified four shared priorities across the UK. They are: Sustainable Consumption and Production; Climate Change and Energy; Natural Resource Protection and Environmental Enhancement, and Sustainable Communities.

Benefits: Because traditional buildings consume large amounts of energy and other natural resources and can harm the environment around them, there is a swelling interest in designing, building, and occupying more environmentally sensitive structures.
The benefits associated with sustainable construction can be divided into environmental, economic and social types:

- Environmental benefits include improved air and water quality, reduced energy and water consumption and reduced waste disposal.
- Economic benefits include reduced operating costs, reduced maintenance costs, and increased revenue via sale price or rental.
- Social benefits include enhanced occupant comfort and health, reduced absenteeism and turnover rate, and reduced liabilities.

The sustainability of the built environment is dependent on a fundamental shift in how resources are used (from non renewable to renewable, and from high levels of waste to high levels of reuse and recycling) and from projects based on lowest initial cost to those based on whole life value and full cost accounting (Kibert C. et al.., 2000).

2.2Energy Models

Computer-based simulation methods offer a powerful and flexible tool for building energy analysis (Joseph C.et al. 1991) and energy conservation programmes. Since the late 1970s, building energy service programmes (BESPs) developed on mainframe or mini-computers have been used for energy conservation activities. DOE-2 (LBL 1981) and BLAST (BLAST Support Office 1991) are examples of BESPs that can perform detailed hour-by-hour load and energy calculations for each of the 8,760 hours in a year. In order to standardize and facilitate the analysis process, efforts have been made to develop subroutines for automating the simulation process, extracting results, storing and manipulating the voluminous output generated from the simulation runs.

Sam C. M. Hui and K. P. Cheung (1997) discussed a multi-year (MY) approach to building energy simulation and presented a pilot study in Hong Kong that investigated long-term building energy performance using MY weather data. Building energy simulations in the pilot study were carried out using the DOE-2.1E program. A set of 17 years of hourly weather data (1979-95) was taken as the weather input to drive the simulation. It was found that the MY approach can provide better analysis of long-term building energy performance and climatic properties. Although the MY approach has many advantages, it does require more data and computations. The availability of MY weather data is a critical limiting factor at present. Accurate and reliable weather data are crucial for building energy simulation and analysis. In the past, MY weather data was seldom used in building energy simulation because the costs and time involved are substantial. With the increase of computing power and development of building energy simulation methods, the use of MY weather data becomes more feasible and is worth examining at this stage.

Chirarattananon & Taveekun (2004) tested a model for predicting energy consumption for buildings based on the Overall Thermal Transfer Value (OTTV), Such a building parameter is based on the thermal characteristics of the building (wall composition, glazing type, wall-window ratio, etc.). The OTTV values are then correlated with other parameters such as shading coefficients, lighting and equipment density in equations that are developed for different building occupations (hotels, commercial buildings, hospitals, etc.) and for the different months of the year. The energy consumption of several buildings was audited (DOE-2 http://gundog.lbl.gov/dirsoft/d2whatis.html) and runs were performed in order to validate the model. The proposed model has a fair correlation with the values produced in the auditing process and simulation. The model reproduces the behaviour of the energy consumption profiles but it has poor prediction in several cases, especially for hotels and hospitals, but good predictions for department stores and commercial buildings.

2.3 State-of-the-art of energy profiling simulation software and Standards

There are several ways to attempt to model a building and its heat gains from external or internal sources to evaluate a proper operation and audit retrofit actions. These models apply various techniques varying from simple regression to more physically grounded models. A frequent hypothesis for all of these models is that the input variables should be based on realistic data when they are available, otherwise the evaluation of energy consumption might be highly under or over estimated, (Alberto H. N., Flavio A. S., 2007).
The certain reviewed indentify the following tools:

2.3.1. Integrated Environmental Solution Ltd <Virtual Environment > software

Simulation consultants IES Limited have used the building performance modlling capabilities of its <Virtual Environment> software (IES-VE) to help in the development of a given design. The software can compare and contrast how different design choices affect the performance of a wide range of building elements, such as thermal, airflow and lighting performance, energy and CO_2 consumption. A structured simulation approach encompasses all the latest cutting edge simulation techniques, for example, external wind studies, thermal, airflow and lighting studies.
Using Heathrow Terminal 5 as a case study (http://www.iesve.com) Building Services Consulting Engineers (DSSR) and British Airports Authority selected IES Consulting and the IES-EV building simulation software for a number of reasons:

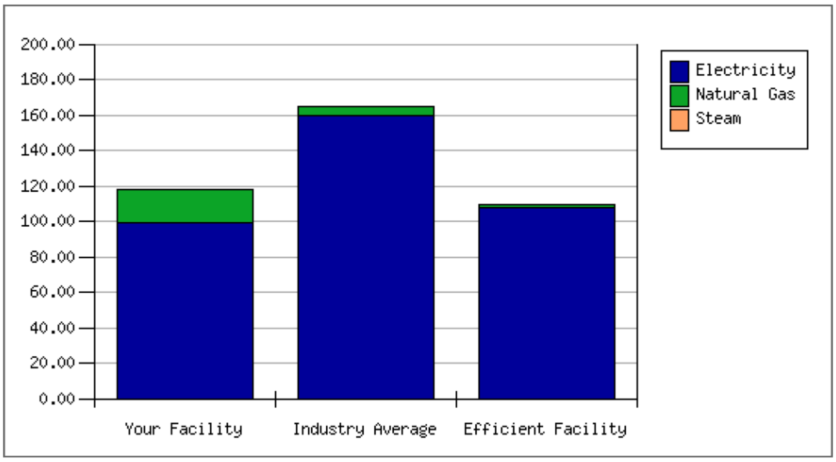
- The unique integrated data model meant that the simulation processed faster and the data and analyses were managed in a controlled and structured manner.
- No special customisation was required, and the software could be adapted to the needs of the project.
- The <VE> simulates the building as a complete entity, taking into account climate and site as well as factors like light, shade, ventilation, energy, carbon, lifecycle costs, occupant safety and economics.
- Performance analysis provides the qualitative and quantitative data needed to optimise the integrated elements of the design.
- This holistic approach ensures architectural considerations and engineering systems can work together effectively from the start.
- Key decisions can be made much earlier in the design process, maximizing opportunities to reduce the building's energy use and carbon footprint.
- The value for this tool is that it has an in depth energy analysis by integrating with the Energy plus.

2.3.2 Energy Profile Tool

The Energy Profile Tool (www.EnergyProfileTool.com) is a customized, commercially available energy analysis tool developed by EnerSys Analytics Inc. and XModus Software Inc. It allows you to enter information about your facilities and it provides detailed profiles of the energy use, as well as benchmark comparison results. The tool helps to identify opportunities to reduce energy and costs, and take the next steps to long-term savings.
The purpose of energy assessment is to provide information about how energy is used a point of reference for comparisons to other similar facilities, for direction to potential energy savings opportunities. The assessment and recommendations are based upon the information provided to the Energy Profile Tool. It retains detailed information about the information and data that was used to conduct the energy assessment. The Energy Assessment for Sample Large Office is used as a case study.
The accuracy of this assessment and the resulting recommendations are directly influenced by the degree of accuracy of the data that was input to the Energy Profile Tool. In addition to the data inputs, a number of other factors such as weather variations, building occupancy and operation schedules can affect energy usage and consequently energy cost savings. Typical characteristics for these other factors were used in the simulation model to calculate energy consumption and conduct this assessment. The assessment is not intended to predict the future effect of any changes made but rather to provide guidance and focus on the greatest potential energy savings opportunities and recommend next steps. It features:

- Comparison of energy consumption and use patterns with other similar facilities assessing current state to develop improvement targets for the future.
- Comparisons of greenhouse gas emissions of the facility with industry averages and an efficient facility (Fig. 1).
- Energy saving opportunities. The tool gives suggestion about best energy management practices for the building (office equipment, outdoor air, operation and maintenance, HVAC controls and lighting).
- Suggestions for the next steps for improvement.

Potential disadvantages of this tool are:



•It is for existing building use only.
•It can only be used for USA climatic conditions.
•It cannot be integrated with 3D models.
.

2.3.3 Green Star Rating

Green Star (http://www.gbca.org.au/green-star/) is an Australia National Tools, comprehensive, voluntary environmental rating scheme that evaluates the environmental design and achievements of buildings. Green Star was developed for the property industry in order to:
Establish a common language; Set a standard of measurement for green buildings;
Promote integrated, whole-building design; Recognise environmental leadership;
Identify building life-cycle impacts; and Raise awareness of green building benefits.

Green Star covers a number of categories that assess the environmental impact that result directly from a project's site selection, design, construction and maintenance. The nine categories included within all Green Star rating tools are:
Management, Indoor Environment Quality, Energy, Transport, Water, Materials, Land Use &Ecology, Emissions Innovation

These categories are divided into credits (Fig. 2), each of which addresses an initiative that improves or has the potential to improve environmental performance. Points are awarded in each credit for actions that demonstrate that the project has met the overall objectives of Green Star.

Once all claimed credits in each category are assessed, a percentage score is calculated and Green Star environmental weighting factors are then applied. Green Star environmental weighting factors vary across states and territories to reflect diverse environmental concerns across Australia.
The following are examples of Green Star certified ratings:

4 Green Star Certified Rating (score 45-59) signifies 'Best Practice'
5 Green Star Certified Rating (score 60-74) signifies 'Australian Excellence'
6 Green Star Certified Rating (score 75-100) signifies 'World Leadership'

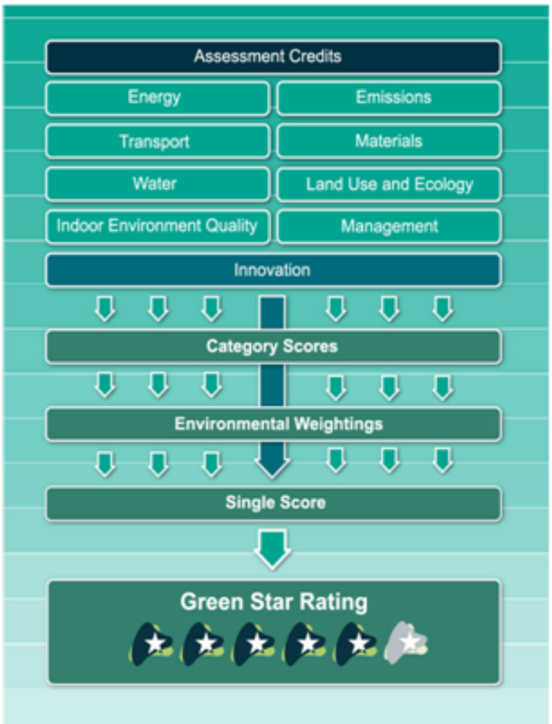


Figure 2: Framework of Green Star Tool

Figure3: Output from Green Star Tool

2.3.4.BREEAM scheme:

BREEAM was released in 1990).
The development of building environmental assessment methods was largely an exercise in structuring a broad existing knowledge and considerations into a practical framework, rather than requiring or demanding new research. Now building environmental assessment is a defined realm of enquiry with more rigorous explorations into weighting protocols, performance indicators, effectiveness – market and physical etc, (Cole R. j., Howard N., Ikaga T., Nibel S., 2005).
The objectives of BREEAM are stated as: (Holmes, J. and Hudson, G. 2000).

- To distinguish buildings of reduced environmental impact in the market place.
- To encourage best environmental practice in building design, operation, management and maintenance.
- To set criteria and standards going beyond those required by law and regulations.
- To raise awareness of owners, occupiers, designers and operators of the benefits of buildings with reduced environmental impact.

Much of the supporting evidence for the success of BREEAM is its influence in changing design and the consequential reduction of environmental damage.

3. Building Information Models (BIM) and Computer Aided Design (CAD) systems

A common definition of a CAD system is “software programs that assist engineers and designers in a wide variety of industries to design and manufacture physical products ranging from buildings, bridges, roads, aircraft, ship and cars to digital cameras, mobile phone, TVs, clothes and of course computers” (CADAZZ, 2004).

Eastman (1999) divides the evolution of computer aided design systems for building projects into three stages:

- In the first stage, a CAD system is used only as a geometric editor, which is described as a graphic modelling tool with inputting, outputting and editing functionality;
- In the second stage, a CAD system is defined as "a platform for application development, which allows users to develop specific-purpose applications to be added on CAD platform; to define the specialized entities with their associated geometry, attributes and topological relations; and to provide special operators to edit and manipulate the special objects". Most CAD systems used today are in this stage.
- The third generation of CAD systems involves integrated applications of 3D and solid modelling, object-oriented languages and databases, effective graphical user interfaces and web-based communication.

Many CAD systems available today are the platforms of further application developments for special purpose implementations. For the separate computational tools to be integrated around a central representation of a building, a building information model, is a new development. (Eastman, Siabiris ,1995).

The definition given by Autodesk (2003) is that Building Information Modelling is an approach to building design, construction, and management. It supports the continuous and immediate availability of project design scope, schedule, and cost information that is of high quality, reliable, integrated, and fully coordinated. Though it is not itself a technology, it is supported to varying degrees by different technologies.

Differing from a 3D CAD model, a building information model:

- Contains the internal relationships between the building elements, which can enable applications to deal with the consequent alternations caused by the changes of a single building element easily and in a timely fashion.
- May contain properties for each 3D building element, including material, related constructing actions, costs, and so on.

All this information is stored as one integrated data repository. This information can enable the user to easily conduct construction scheduling and costing according to conceptual design and rapidly and precisely cope with any changes. (Fu C., 2005).

3.1Revit building information modelling and Sustainable Design:

In current practice, many building models do not contain sufficient information for building performance analysis and evaluation. The Revit parametric building modeller represents the building as an integrated database of coordinated information. Beyond graphically depicting the design, much of the data needed for supporting sustainable design is captured naturally as design in the project proceeds. In addition, the integration of Revit Building with commercially available analysis tools greatly simplifies the often cumbersome and difficult analyses. By linking the building model directly to the analyses software, Revit Building gives architects easy access to tools that provide immediate feedback on design alternatives early on in the design process, (Autodesk Revit White Paper, 2005).

Revit building information modelling can be applied to a variety of sustainable design activities including design optimization, visualization, day-lighting, energy analysis, quantity takeoffs, and specifications management. As building growth intersects with environmental concerns and the rising cost of energy, a growing field within building design has emerged – sustainable design, the practice of designing, constructing and operating buildings in a manner that minimizes their environmental impact. The goal of sustainable design is to produce green buildings that are "environmentally responsible and healthy places to live and work"(U.S. Green Building Council, Mission Statement, 2004).

Revit Architecture offers a rich set of capabilities that supports better sustainable design decision making. For example:

- Revit Architecture sun studies enable designers to analyze sun positions and solar effects while informing the design process.
- Designers can export building information, including materials and room volumes, to green building extensible markup language (gbXML) to perform energy analysis and study building performance.
- Using design options it is easy to develop or evaluate multiple sustainable design alternatives. Visualize, quantify and present any combination of schemes to inform the decision making process. (Autodesk Revit Architecture, 2008).

4. Proposed method and Framework

The aim is to facilitate the integration of Environmental Impact Assessment, Whole Life Cycle Cost and Life Cycle Assessment with 3D technology / (Revit) BIM. These tools will work together to achieve the main goal, to identify synergy between variables and the result will be visualized by using a BIM, and allow decision – makers to allocate a weighting to the different indicators.

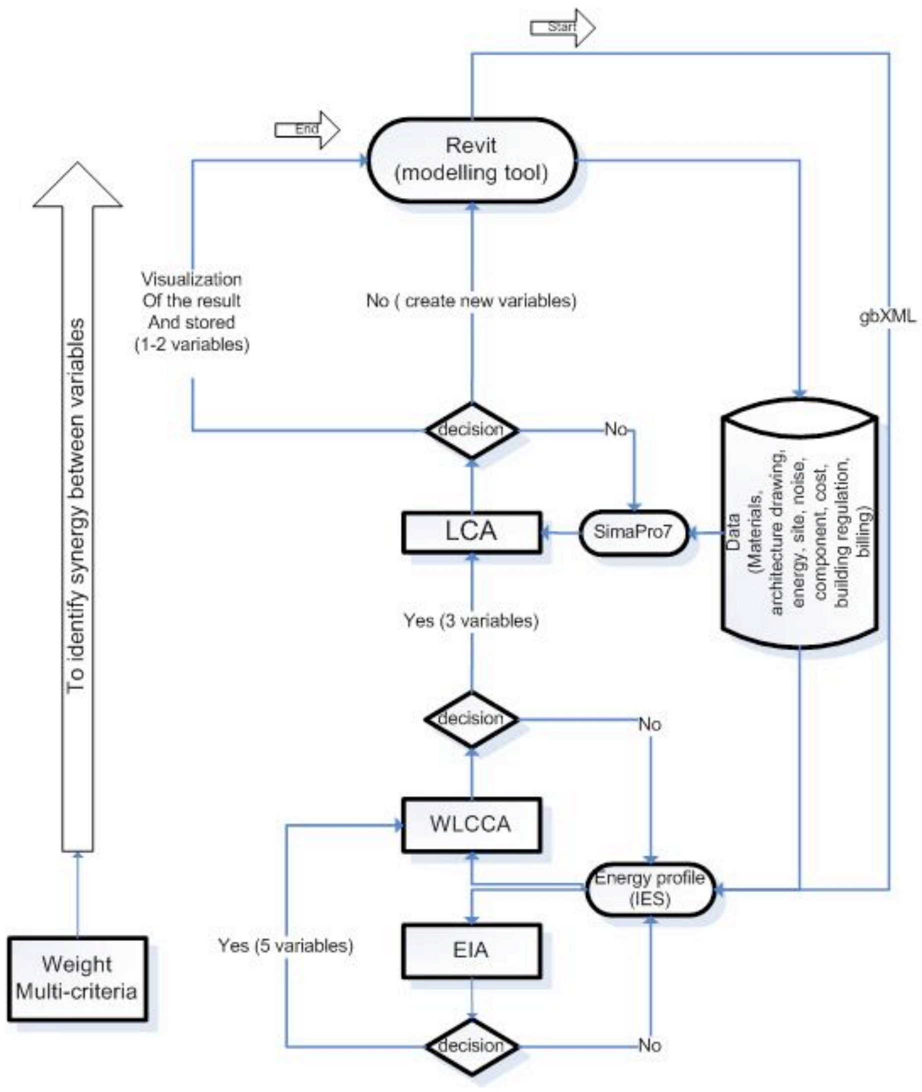


Figure 4: Methodology Framework

The framework focuses includes:

EIA: delivering building with excellent energy and CO_2 performance requires a step change in our understanding of energy and carbon in buildings, so the project will focus on CO_2 emission, waste management and land use.

WLCCA: the ratio of 1:5:200 has been set as the golden fraction of a building life cycle cost, 1 represents construction cost, 5 represents maintenance and 200 represents building operation cost as the business operation cost (Evans, R. 1998), we need to reduce the ratio 200 and contribute to the green agenda by reducing carbon emission of building life cycle. The research adopts IES software tool to assess the EIA and WLCCA.

LCA: the research focuses on reuse, recycling materials and energy consumption in order to maximize energy performance and minimize environmental impact.
Smpio7 tool to assess the LCA
Why SimaPro7: (http://www.pre.nl/webdemo/new/EN/SimaPro_Intro_EN.html)

- The LCA explorer is structured according to the ISO 140140 LCA standard, so we can efficiently build and document our project.
- Libraries with thousands of inventory process, these contain the environmental data for a product or process.
- SimaPro7 comes with the most used impact assessment methods, using these methods to calculate the environmental profile of any model.

Revit: This modelling software will be used as a main platform to visualize the model and the result. In addition, the framework will utilize the building information model (BIM) for design. Many other building models do not contain sufficient information for building performance analysis and evaluation. The Revit parametric building modeller represents the building as an integrated database of coordinated information.
Why Revit?
Revit has many features that allow users the flexibility and freedom to design in a manner that does not constrain them to just 2D drawings. BIM technology and the parametric change engine are the two components which make Revit an incredible force in the (AEC) community, (Krygiel E., Demchak G., Dzambazova T., 2008).

The method is divided into 4 phases:

Phase1: The creation of building information model (BIM) using Revit Architecture software mirrors the real world of buildings, and helps to capture early design concepts. Also BIM is described as a set of information generated and maintained throughout the life cycle of building. The variables have different shapes, orientations, spaces, wall-window ratios, height and land use. This will affect the solar gain, lighting & daylighting, thermal compliance, and value & cost for heating and cooling loads according to sustainability issues, the orientation and the openings size of the variables play a crucial factor for solar gain.

Phase2: Using IES-VE to assess the environmental impact and the cost of the variables, we expect 2 or 3 variables will pass to the next phase if not we going to create new variables. The software can compare and contrast how different design choices affect the performance of a wide range of building elements, such as thermal, airflow and lighting performance, and energy/CO_2 consumption.

Phase3: Using LCA tool (SimaPro7) to assess the life cycle of the variables which have passed the previous phase. Revit is used either to visualize the variables, which pass this stage, or are to be modified start from the first phase.

The databases will play a vital factor in this method, containing: component costs, embedded energy, materials cost, climate data, building regulation data and architectural drawings. We can use existing data base and add new information to it.

Variable	Assessment methods	Criteria	Result	Weight	Result x weight	BRE & standerds rate	BRE score	Compliance	ACOUNT	Yes/No
		CO_2 emission	45	0.5	22.5	40-5 kg/m2/yr	0.92 / 13.75	Yes		
		Heat gain/loss	2.1	1	2.1	1.3-1.1 W/m²K	0.92 / 1.83	No		
		Internal light	50%	2	1	40%-70% low energy	0.92 / 1.83	Yes		
		NO_x emission		0.5	0	100mg/kwh -40 mg/kwh	0.91 / 2.73	Yes		
		Regulation	45	1	45	32 Kg CO2/m2		No		
		Energy consumption	118	1	118	120-58 Wh/m2/yr		Yes		
		Renewable energy	5%	1	0.05	10% - 15%	0.91 / 1.87	No		
	EIA	Daylighting	301	1	301	300-1000 lux	1.75	Yes	5	yes
		Capital cost	2,340,706	0.25	585176.5			Yes		
		Energy cost	239,734	0.5	119867			No		
		Repair cost	9,000	1	9000			Yes		
	WLCCA	Annual cost	70,000	1	70000			No	2	No
		Climate change		2	0					
		Global warming		1	0					
		Land use / Ecology		0.5	0	Ecological value	1.33			
		Recycling Facilities		1	0 0 0	Internal - External storage	0.9 / 2.71			
		Recycle		2	0 0	construction waste on site	1		0	No
1	LCA								1	fail
								Result		
2										
3										

Input of data relating to materials, occupancy, internal gains, climate, air movement and systems is managed via graphical interfaces and supported by extensive databases within IES. In addition the real data could be obtained from energy bills, manufacture's materials guide.

Phase4: Comparison with BREEAM compliance:
As described earlier, this study will have two targets: Firstly, integration of the three approaches (EIA, WLCCA and LCA). Secondly, to consider a standard outline design processes based on Royal Institute of British Architect (RIBA) work stages and associate these with environmental legislation including ISO standards and European Environmental Law. The results from the framework will be compared with BREEAM standards or other standard figures. Table 1
The focus of the criteria is on the requirements and operation of the EIA, WLCCA and LCA. The main environmental requirements in EU are: (Streimikiene D.2005)

- Promoting energy efficiency and use renewable energy sources
- Implementing economic tools of environmental regulation
- Targeting reduction of pollutants emissions into atmosphere

Case study description:

Model Data: Total conditioned floor area= 2144.74 m2, total conditioned volume=6680.65 m3, number of room = 9, climate file name, location Manchester, calculated at 16:00 on 04/Jun/08, Calc. Period: 01/Jan - 31/Dec

Table.1. shows the results from the tools and BREEAM standards figures

The table shows the result of case study to demonstrate the framework and the methodology.
The method of integration of different criteria uses weightings decided by the architect or design team and the trade-off analysis for the criteria will appear on the compliance field. The optimum design has to have three compliances to pass the assessment by comparing the result of the criteria with the standard figures. The spreadsheet will take account of the number of compliances for the three methods (EIA, WLCCA and LCA), and automatically pass or fail the proposed design. The integration of the three approaches and BIM and develop synergy analysis (table 1) to assist in decision making process.

5. Conclusions

This paper aims to give an overall review of the knowledge and technologies in the research area. We present a framework, methodologies and technologies that will facilitate the integration of Environmental Impact Assessment, Whole Life Cycle Cost and Life Cycle Assessment using 3D and BIM technologies.

- Current evaluation tools are used after buildings are fully designed and therefore corrective decisions are costly and difficult to implement.
- Tools can be used to detect and calculate energy use but not always as a method of reducing them.
- There is no consideration of waste management and renewable energy that might be vital for sustainable buildings.
- To assist the architects and building developers in making accurate decisions when designing buildings an integrated database would ensure that all of the relevant information is available.
- Faster and more accurate energy analysis at the early stages of the design processes should lead to efficient building designs and lower operating cost for owners.
- The use of sustainability tools at the design stage is a possible route towards meeting government policy on sustainable development via building design comparison and improvement.
- A building could be designed with full knowledge of the environmental impact of the building over its life cycle by the use of VR images in the whole life cycle analysis and in the control of energy / emissions / ventilation / materials / orientation to estimate the operation and maintenance costs of project alternatives all through the facility's expected life-span.
- Integration of different assessment tools around a central representation of a building (Building Information Model) is a new trend in the design development processes. It allows stakeholders to understand the flow of tasks/practices during early design stages that can lead to carbon minimization

Future development will be as follows

- To develop a prototype to verify the framework and to run scenario analysis.
- To collect and use case studies to demonstrate the benefits to be derived from the use of the prototype and to compare the outputs with current practices.

6. References:

Alberto H. N., Flavio A. S., (2007). "Use of Simulation Tools for Managing Buildings Energy Demand". Building Simulation p.p 1883-1889

Agremant and Evans (2004). "Just sustainable: The Emerging Discourse of Environmental Justice in Britain". The Geographical Jurnal, 170 No.2, p.p 155-164.

Autodesk (2003, 2005). The Autodesk white paper-"Building Information Modelling in Practice". Autodesk Company, US.

Autodesk Revit Architecture, (2008). Question and Answers www.autodesk.com/revitarchitecture.

CADAZZ, CAD Software History, http://www.cadazz.com/index.htm , Review in October 2004.

Cole R. J., Howard N., Ikaga T., Nibel S., (2005). "Building Environmental Assessment Tools: current and future roles". http://www.sb05.com/academic/4&5_IssuePaper.pdf

Chirarattananon C. and Taveekun J., (2004). "An OTTV-based energy estimation model for commercial buildings in Thailand". Energy and Buildings, Vol. 36, Issue 7, p.p. 680-689.

DEFRA (Department of Environment, Food and Rural Affair), (2004, 2005). Energy efficiency: the government plan's for action.

Eastman C.M. and Siabiris A. (1995). "Ageneric building product model incorporating building type information. Automation in Construction". Vol.3, no.4 p.p 283-304.

Eastman, C.M. (1999). "Building Product Models: Computer Environments Supporting Design and Construction". Florida: CRC.

El-Haram m., Walton J., Horner M., Hardcastle C., price A., Bebbington J. and Atkin-Wright T. (2005). "Development of an Integrated Sustainability Assessment Toolkit". Engineering Sustainability, Vol. 158 p.p. 57-65

Fowke R. and Prasad D. (1996) Sustainable development, cities and local government, Australian Planner, Vol. 33, pp 61-66.

Fu C., (2005). "Integration and Interoperability of IT Applications and Information in Construction-A Study in nD Modelling". PhD Thesis, University of Salford, UK.

Evans, R., Haryott, R., Haste, N., Jones, A. (1998). "The Long Term Costof Owning and Using Building" The Royal Academy of Engineering. www.arcom.ac.uk/publications/procs/ar2004-0373-0381_Hughes_et_al.pdf

Joseph C. Lam and Sam C. M. Hui, (1991). "Computer Simulation of Energy Performance of Commercial Buildings in Hong Kong". Building Simulation'93, p.p 129-135 (26)

Holmes, J. and Hudson, G. (2000). "An evaluation of the objectives of the BREEAM scheme for offices", a local case stud: The Cutting Edge 2000, University of Northumbria at Newcastle, UK.

Kibert C. J., Sendzimir J., and Guy B. (2000). "Construction ecology and metabolism: natural system analogues for a sustainable built environment". Construction Management and Economics, Vol. 18, p.p 903-916.

Krygiel E., Demchak G., Dzambazova T., (2008). "Introducing Revit Architecture" book

Loh E., Dawood N., Dean J. (2007). "Integration of 3D Tool with Environmental Impact Assessment 3D-EIA". 3rd Int'l ASCAAD Conference on Em'body'ing Virtual Architecture [ASCAAD-07, Alexandria, Egypt]

Mark A. Shelbourn, Dr., Dino M. Bouchlaghem, Prof., Chimay J. Anumba, prof., Patricia M. Carillo, Prof., Malik M. k. Khlfan, Dr. Jacqueline Glass, Dr. March (2006)." Managing knowledge in the context of sustainable construction". http://itcon.org/2006/4/

Ness B, Urbel-Piirsalu E, Anderberg S, Olsson L. (2007). "Categorising for sustainability assessment" Ecological Economics, Vol. 60 issue 3 p.p498-508

Parkin S., Sommer F., and Uren S., (2003). "Sustainable development: understanding the conceptual and practical challenge". Engineering Sustainability, Issue ESI, p.p. 19-26

Sam C. M. Hui and K. P. Cheung (1997)."Multi-year (MY) building simulation: is IT usful and practical". Building Simulation, Vol. 97, pp. 133-140

Sage. (1998). "Risk management for sustainable development". www.ieeexplore.ieee.org. vol. 4. p.p. 4815-4819.

Streimikiene D., Raltic C., Dainora G. (2005). " Energy indicators for sustainable development in Baltic States" Renewable and Sustainable Energy Reviews 11 (2007) p.p. 877-893. www.elsevier.com/locate/rser

Sue-MoT. (2003). "Report from sue-MoT workshop "Consortium comprising Dundee, Caledonian and Loughborough Universities. (17 November 2003). Royal Statistical Society, London. www.sue-MoT.org.uk

Sue-MoT. (2004). "Report from sue-MoT workshop2". Consortium comprising Dundee, Caledonian and Loughborough Universities. (5 July 2004). Royal Statistical Society, London. www.sue-MoT.org.uk.

U.S. Green Building Council, Mission Statement, (2004). www.greenbuildingpages.com/press/GBPES.pdf

WCED (1987). Our Common Future, Oxford University Press, Oxford, UK.

Mapping the sustainability of small business locations

Alice Dalton

University of the West of England, UK

Small to medium enterprises (SMEs) account for 63.7% of employment, 99.7% of employers and 53.8% of the economic turnover in the south west region (Department for Business Enterprise and Regulatory Reform 2008). Their involvement in long-term sustainable economic development is therefore significant. Empirical research into the needs and decision-making of SMEs is limited, with existing literature and guidance relating mainly to larger businesses and large office premises. This research seeks to understand office location decision-making by small businesses at the local scale in the Bristol city-region and to analyse the sustainability of their office locations. This will provide insight into the economic, environmental and social sustainability of current economic growth and will evaluate the current spatial planning policy framework, in order to help identify what is required for sustainable economic development in the future.

An online questionnaire has been completed by 215 SME office users in the Bristol city-region. The most important factors when choosing a location are cost, floorspace and broadband availability. Analysis of the comments made by respondents, however, reveals a strong behavioural rationale behind location choices and a more complex approach to decision-making than that of larger businesses. Only a few businesses have adopted the alternative business model of the 'virtual office', where location is less relevant. Spatial analysis has been carried out in a geographic information system (GIS) to understand the accessibility of office locations to public transport networks and nodes, and to services and facilities needed by businesses. Results suggest that existing premises may not be in sustainable locations according to current guidance. Mapping the 'softer' factors of decision-making, such as 'quality of life' criteria is complex, and current methods for assessing sustainability may not be appropriate for this. The findings of this research have implications for future spatial planning policy, current assessment methods, encouraging the growth of small businesses and preparing for sustainable growth in the future.

Keywords: Bristol city-region, accessibility, geographical information systems, small to medium enterprise, sustainability assessment

1 Introduction

Small to medium enterprises (SMEs, businesses with fewer than 250 employees) account for 63.7% of employment, 99.7% of employers and 53.8% of the economic turnover in the south west region (BERR 2008). Their involvement in long-term sustainable economic development is therefore highly significant. The need for an office premises is a requirement of the majority of SMEs with employees, but the sustainability of these actual office locations (rather than the building itself) is not well documented. The location of an office building will impact upon carbon dioxide emissions, travel behaviour, employee well-being, client/customer contact, general accessibility and overall business success. This will influence the sustainability of economic development at the local level, but also in the wider context. Furthermore, empirical research into the needs and decision-making of SMEs is limited. Understanding location decision-making by businesses and the sustainability of the locations that are being chosen may help the region prepare for sustainable economic development in the future. The research is informed by an online survey of 215 SMEs and the spatial analysis of data in a geographic information system (GIS).

2 Research aim

This PhD research (in progress) aims to understand office location decision-making by SMEs at the local and sub-regional scale in the Bristol city-region (Figure 1). The sustainability of office locations is analysed, building on (and evaluating) current literature, guidance and debates in the field. This will reflect on the economic, environmental and social sustainability of current economic growth for small business in the area, provide insight into implications for the future and evaluate the current spatial planning policy framework.

3 Office location and the sustainable city-region

Empirical research seeks to explore what influences business location in order to understand behaviour and process, to assess economic activity in the past and make predictions for the future, to evaluate previous policy approaches and ascertain what is required for the future. By understanding what is required from an office location, business needs can be understood, office premises can be developed appropriately and Government policy can be based on empirical findings. This is a requirement of planning policy in England referred to as 'evidence-based' policy, with the new system of Local Development Documentation requiring 'a robust, credible evidence base' in order to meet planning requirements (ODPM (now CLG) 2004: 1). It is evident that traditional theory of business location is not sufficient to help understand the location of office activity. Empirical evidence must be gathered and assessed in order to understand what decisions businesses are making on to try to understand why. By gaining this knowledge, the development of future policy can be more aligned with businesses needs and will allow an insight into the requirements for a more sustainable form of economic growth. Much empirical research has been conducted into location decision-making of businesses at the different stages of start-up, expansion and relocation. The majority of this work has focused on large businesses, meaning that comparable studies on smaller businesses are rare, despite the contribution they make to the economy and the potential environmental impact they may have. In order to understand what must be done to encourage sustainable economic growth, factors influencing business decisions regarding locations must be explored.

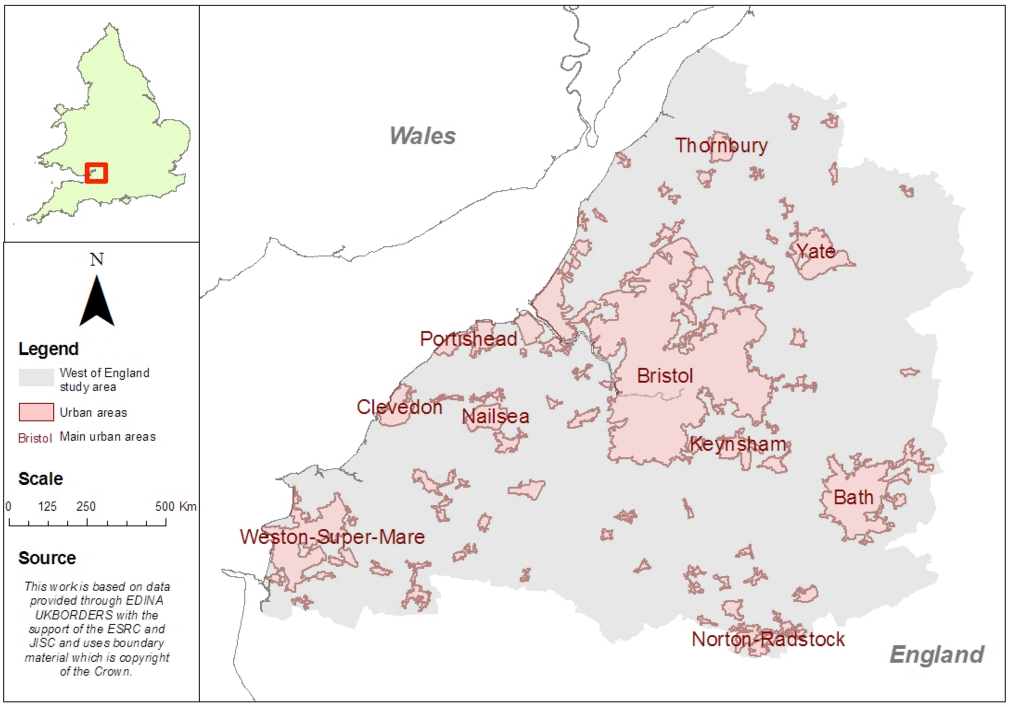


Figure 1. The West of England study area and associated urban areas

The city-region provides a suitable scale of focus to examine economic activity (Ravetz 2000; Green 2005). There is a need to understand current economic activity to enable successful future planning, particularly in city-regions. A recent report to national Government noted that 'rapid economic change had overtaken the working assumptions of urban planners and economic development officers alike' (Townsend and Tully 2004: 3). It was recommended that research be conducted to ascertain which businesses are 'amenable to different kinds of sites within a City Region' (ibid, p 4). The city-region incorporates the city centre, surrounding suburbs, surrounding towns and rural areas. This scale of analysis is essential for 'joined-up thinking' as the city cannot be viewed in isolation (Ravetz 2000). The whole area should be considered to links between local, regional, national and even the global scale (Ravetz 2000). This is particularly evident with needing to coordinate solutions to housing, workplace location and transport networks (Green 2005).

The following sustainability objectives have been taken from Ravetz (2000: 9). These are seen to realistically represent the process of sustainability in the context of economic development in the city-region.

- Environment: reduce environmental impact and resource use to 'sustainable' levels, and enhance environmental quality and safety.
- Economy: to enhance long term resilience, competitiveness, employment, and equitable distribution of resources.
- Society: to enhance health, education, security, equity, cohesion, diversity and 'quality of life'.

The importance of good access to public transport networks is crucial in order to reduce car dependence and make sustainable transport options available to those using office premises (Stead 2000). The 'social sustainability' angle is important too, in order to maximise the quality of life both for the staff employed by the company and the wider community. This in turn impacts on the business as recognised by Sayce and Ellision (Sayce and Ellison 2003; Sayce and Ellison 2004; Sayce, Ellison et al. 2004), in that staff retention is clearly affected by the accessibility of the business premises. Harvey (2007) notes that a 'human-centric perspective' is crucial rather than focusing on 'green' goals, particularly as the cost of hiring staff is the major expense for small businesses. This agrees with research showing that while businesses are keen to invest in 'raised staff satisfaction' and 'improved company image', they are 'only prepared to pay marginally more to occupy an environmentally efficient property', suggesting that the benefits to business are much greater from the social sustainability angle (GVA Grimley 2006). What exactly constitutes 'accessible' and which criteria should be considered has been widely discussed, as outlined in Table 1. This guidance can be used to identify accessible areas for future developments and can also be used to evaluate existing developments. Based on this review of the literature, it can be deduced that an office should be within a maximum distance of 1000m of a railway station or 650m of a bus stop in order to meet sustainable accessibility targets regarding public transport. This can be analysed by mapping accessibility information and modelling distances in a GIS, providing an insight into which office premises (existing and potential) are located in potentially sustainable locations and which are not.

Table 1. Sustainable location criteria in the literature

Organisation	Date	Assessment	Sustainable location criteria
Building Research Establishment (BRE) (UK)	2008 (revision)	Environmental Assessment Manual for offices (BREEAM)	Frequency of public transport within 650m of the office building for bus stops and 1000m for railway stations (TRA1); where the building is located within 500m of a grocery shop and/or food outlet, Postbox and cash machine (ATM) (TRA2)
London Borough of Hammersmith and Fulham (UK)	1992	Public Transport Accessibility Level (PTAL) system	8 minutes to/from a bus stop (640m) and 12 minutes to/from a train station (960m)
Green Building Council (USA)	2005	Leadership in Energy and Environmental Design Green Building Rating System™ (LEED)	800m from a commuter rail, light rail or subway station; or 400m from two or more public or campus bus lines suitable for employee use
South West Regional Planning Guidance (RPG10) (UK)	2001	Interim Transport Accessibility Criteria (Annex A: Accessibility and Parking Standards)	300m target distance, 600m maximum to a food shop and primary school; 600m/1000m to other non-residential facilities; 200m/400m to a bus stop; 600m maximum to a bus station; 800m maximum to a railway station; plus maximum travel times
Department for Transport (DfT) (UK)	2004	Accession	30 minute maximum time for accessing various facilities and workplace by public transport
Griffith University's Urban Research Program, Australia (Pitot et al. 2006)	2005	Land Use & Public Transport Accessibility Index (LUPTAI) Tool	5 minutes to/from a bus stop (400m) and 10 minutes to/from a train station (800m)

4 Research questions

Based on a review of existing literature and the current state of knowledge in this field, three research questions have been established for this research:

1. What determines the locations of office-based SMEs in the West of England?
2. What is a sustainable location for office-based SMEs in the West of England?
3. Are SMEs choosing sustainable locations for their office premises?

The following section will provide an overview of the research strategy used to answer these questions.

5 Research design and method

5.1 Definition of terms

Exploratory face-to-face semi-structured interviews with businesses (summer 2007) revealed that staff well-being, proximity to facilities and accessibility are the most important factors for economic success. In consultation with relevant literature, a sustainable location for an office-based SME is defined as maximising workplace quality of life and accessibility while resulting in minimal environmental impact. For a location to be environmentally sustainable it can be argued that it must be accessible by public transport, in order that carbon dioxide emissions can be reduced. For a location to be sustainable for the business, the office may need to be accessible for employees, to clients and to a range of facilities and services.

5.2 Sampling procedure

Businesses were selected from the Financial Analysis Made Easy (FAME) (Jordans Limited 2008) database of registered companies. A total of 1025 met the following eligibility criteria: A live SME (EC classification including micro, small and medium enterprises); at least one employee; a non-retail office premises (based on Standard Industry Classification (SIC) 2003 codes); in the West of England (Bath and North East Somerset, Bristol, North Somerset and South Gloucestershire); contactable by post or email (with addressee and address detail). A saturation sampling method was deemed necessary, where all identified eligible respondents would be contacted. This was particularly important when considering that not all SMEs are actually included in the database of registered companies. In fact, at the start of 2007 there were 417,910 enterprises in the south west according to BERR (2008), but according to FAME, there are currently only 324,146, just 77.6% of the total. However, this was the only realistic way of identifying and accessing information on individual companies and being able to obtain their details. The size of the sample ensured that it was feasible to invite all businesses in the sample to participate.

5.3 Business survey

An online questionnaire was used to collect responses from the selected businesses. This method was deemed most appropriate due to the sample size, a need to obtain quantitative data for comparison purposes, the assumed Internet accessibility of respondents and the constraints of time, resource and cost. The questionnaire was pre-tested then piloted on six of the businesses. Feedback from the testing process recommended the addition of response options and amendment of some of the question formats. In order to maximise the response rate, a variety of measures were taken based on guidance provided in the literature (Tomaskovic-Devey 1994; Anderson and Gansneder 1995; Dillman 2000; Bartholomew and Smith 2006). This included explaining the subject and purpose; emphasising the importance of, and to, the West of England sub-region; informing the respondent of sponsorship by the South West of England Regional Development Agency (SWRDA) and academic institutions of the University of Bath and UWE; using personalised contact wherever possible; providing an incentive (to express their views and to obtain summary feedback regarding other businesses); legitimising the research (sponsorship, logos and UWE email address or headed paper) and providing contact details; allowing respondents the choice to complete the questionnaire online, by post or via email; using a personalised subject line for the email invitations and individual addressee details for the postal invitations; sending invitations on a Monday or Tuesday; and ensuring the request was sent to the most suitable person.

Respondents were asked a series of questions including: where their office was located; which factors were important when choosing their office location from a pre-specified list; where their employees were located; modes of travel to work; and the perceived advantages and areas of improvement for their current office location. Each non-respondent was sent three follow-up notifications.

The questionnaire was completed by a total of 215 eligible businesses out of the sample of 1025, a response rate of 21%. The low response rate was expected due to the often quoted difficulty of conducting surveys of small businesses (Dillman 2000; Lewis et al. 2007). In fact, this is identical to the average response rate of calculated from published journal articles in the 1990s (Paxson 1992 cited in Dillman 2000: 323). There was a disproportionate non-response by micro companies, where 84% of invites went to micro companies, but only 46% of responses were received by them. This was deemed a sufficient response not to warrant booster sampling or grossing up as the response were not designed to be representative.

The data had to undergo a thorough cleansing process prior to the analysis stage. Only 215 of a total of 330 respondents who accessed or completed the questionnaire were eligible. In part this was due to the inability of assessing eligibility of respondents prior to contact. For example, a business may have a registered address in the study area of may be located elsewhere; they may have changed since submitting information to the database (address, name, number of employees), they may not have an office premises that they use; they may have merged with another or ceased operation; and information in the database may have been incorrect. Some organisations provided duplicate responses where more than one individual had started or completed the survey, and some responses were not complete.

5.4 Data analysis

The data analysis stage of this research is ongoing and two main aspects of this have been, or will be, completed. One aspect involves investigating and spatially analysing the responses received from the survey (research question 1). The second aspect concerns mapping the sustainability of locations and office buildings in the study area based on the literature, including sustainability assessment criteria such as BREEAM (BRE 2008) and validated by the empirical research (research question 2). The results of these will inform the discussion concerning sustainable decision-making by SMEs (research question 3). These are discussed below.

5.4.1 Business survey

Descriptive statistics have been extracted from the responses based on the quantitative responses regarding important location criteria, and qualitative responses of perceived advantages/areas needing improvement regarding the office location of SMEs.

The office locations of the business respondents have been georeferenced based on postcode information using Ordnance Survey Code Point® data, then mapped in a geographic information system (GIS). In order to analyse employee locations relative to the office location, the distance that employees travel to each office location is being analysed. This has been based on straight line distance (using 'Hawths Analysis Tools for ArcGIS', Beyer, 2004), road distance and rail distance (using Network Analyst OD Cost Matrix facility in ESRI's® ArcMap™ 9.2, based on the Ordnance Survey Meridian2 transport network). This will reveal specific travel to work areas at the individual business level. By using information provided regarding mode of travel, it may be possible to indicate the carbon dioxide contribution of SME office users in the sub-region.

5.4.2 Office location sustainability

Locations within the study area have been analysed in terms of sustainability for office premises. As discussed in Section 3, various methods for assessing sustainability have been developed as guidance for development. The initial stages of the analysis have mapped the criteria set in RPG10 and the distances specified in the recently revised criteria by BRE (August 2008) as part of the Environmental Assessment Method specifically for offices (Table 1). The BRE method attributes credits to an office premises based on satisfying specific sustainable transport criteria. National Public Transport Access Nodes (NaPTAN) data from the Department for Transport were used, mapping the locations of bus stops, railway stations and bus stations. Valuation Office Agency (VOA) data was used for RPG10 to identify various services (GPs; schools – nurseries, primary, secondary; opticians; dentists; pharmacies) and facilities (shops, childcare, supermarket, pubs, leisure, religious, other social); and for BREEAM to identify the location of cafes, banks, food shops, ATM's and Post Offices. Royal Mail data was used to identify Postbox locations. The Network Analyst OD Cost Matrix facility in ESRI's® ArcMap™ 9.2 was used on the road network extracted from Ordnance Survey Meridian2 to calculate 'service areas' for public transport nodes (points) and services/facilities, using the maximum distances as specified in the BREEAM and RPG10 criteria. This gives a general indication of how sustainable a location can be.

BREEAM is designed to be carried out at the individual property level, not for assessing a wider area; therefore calculating general 'service' or 'accessibility areas' is not so appropriate. VOA data and respondent information identified a total of 7522 office premises in the study area. The sustainability of each of these locations is currently being analysed to calculate actual distances from offices to public transport nodes (points) and services/facilities nodes. This will calculate an Accessibility Index as defined in BREEAM, using the Public Transport Accessibility Level technique (Appendix B, Transport for London 2006). OpenStreetMap data is formatted and validated for use to supplement the Ordnance Survey data, in order to calculate accurate walking distances based on all pedestrian routes as well as road networks. Public transport frequency data is being compiled using the National Public Transport Data Repository (NPTDR) (Thales 2009), to assess the quality of services available at public transport access nodes. This gives a specific indication of how sustainable a particular office building could be.

Mapping BREEAM criteria is problematic for multiple locations. Postbox information exists in a PDF from the Royal Mail but only 14% of boxes have full postcodes (and there are nearly 3000 Postboxes with Bath and Bristol postcodes). The rest are just the higher level (BS1 and so forth), requiring manual georeferencing using the street name to map the locations. In elation to cash machines, it should be noted that money can be obtained from locations other than ATMs, such as Post Offices and shops that offer 'cash back'. Identifying grocery shops and food outlets is almost impossible to obtain accurate data for. Sandwiches and so forth can be bought from a vast range of shops that are not included as specific cafes/food shops by the VOA. Shops and kiosks are not specified according to type of product sold. Manual survey would be required to identify each location, but these would be constantly changing. It is questioned whether it is possible to use proxies for the criteria. As an example, density mapping was carried out for all services in the VOA database to identify areas that had the highest clustering of such facilities (the top quartile) for RPG10 guidance (Figure 8) and is currently underway for BREEAM guidance. It appears that this may also be a more accurate reflection on services and amenities used by staff, rather than using the criteria specified in TRA2. In order to verify if this approach would be appropriate, site validation is being carried out for a small sample area in the Bristol city-region.

Gravity modelling has been used to examine the relationship between office location, sustainability factors and employee location. The Keeble et al (1981) gravity modelling concept is based on the principle of the 'economic potential' of an area being a function of its attractiveness and of its proximity to other urban areas (Copus 1999). For example, the economic potential of Bristol is the sum of the size of each other urban area divided by its distance to Bristol. The model is used in this research to assess the suitability of areas in the Bristol city-region for office locations, and to assess the influence of accessibility on the suitability of these areas. Gravity models have been said to represent over-simplified models of reality using just functions of size/attractiveness and distance. However, by weighting locations according to the calculated accessibility indices, the model can more accurately reflect differences in location.

The sustainability ratings attributed to office buildings is analysed, comparing different classification systems, assessing the sustainability of office stock in the study area and evaluating the location of actual office location. Survey responses regarding advantages and needed improvements of their office locations, will be compared to the indicative sustainability rating of their building. This will allow an insight not only into the sustainability of office locations used by SMEs, but also into the appropriateness of sustainability rating systems, suggesting if the criteria are valid for SME office users.

6 Results

Results are provided here from the initial findings of the analysis, based on the three aspects of analysis detailed above.

6.1 Business survey

Quantitative data collected from the survey reveals that factors of cost, floorspace and broadband availability are most important when choosing an office location (Table 2). This is based on the mean score of the variables, a method used to find the most and least important factor using the variable scale.

Interestingly, analysis of the comments made by respondents regarding the advantages of their location and areas for improvement, suggests that these factors may not be as important. Factors relating to transport and accessibility were most frequently mentioned, accounting for nearly 50% of all responses. Proximity to city/town centre was the most frequently mentioned advantage of respondent's office location (mentioned 60 times, equivalent to over 10% of all responses). Respondents mentioned various aspects of being near to a town centre, including amenities, ease of access, atmosphere, centrality and quality of the surroundings. Local environment was the most frequently mentioned factor that the respondents would like to see improved at their office location (mentioned 62 times, equal to over 17% of responses). Respondents mentioned various aspects of their local environment, including: air quality, street cleanliness, amount of green space, signage, noise, drainage and the 'public realm' generally.

In terms of travel to work results, 53% of employees travel to the office by car and 44% travel by public transport, bicycle or on foot (Figure 2). Even though the data collected as part of this research is not designed to be representative of all businesses in Bristol city-region, the figure of 53% is close to the figure of 56.5% quoted by the Office for National Statistics in 2007 for this area (ONS 2007). The ONS also publish data regarding average distance travelled to work. This is being calculated using responses to the survey regarding employee locations and spatial analysis as outlined in Section 5.4.

Table 2. Mean scores of location variables from the survey of 215 SME office-users in the Bristol city-region

Factor	**Mean score of variable (1 = very important)**	**Rank of variable**
Cost of premises	1.57	1
Floorspace	1.58	2
Broadband Internet availability	1.66	3
Access by car	1.75	4
Proximity to employees	1.90	5
Director's personal preference	2.11	6
Environmental quality of surroundings	2.21	7
Safety/crime levels	2.33	8
Access by public transport	2.44	9
Prestige of location	2.47	10
Access to customer/client	2.63	11
Access to shops and restaurants	2.79	12
Proximity to similar business	3.16	13
Proximity to university	3.50	14

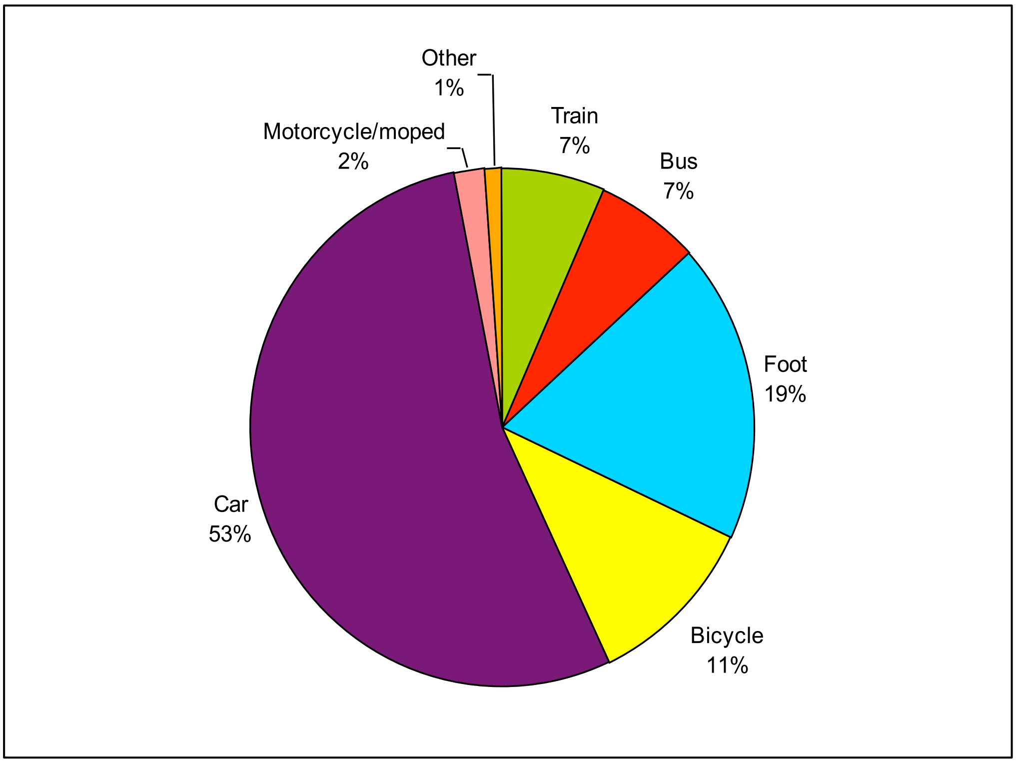


Figure 2. Mode of travel to work of employees working at the offices of the 216 businesses surveyed

6.2 Location sustainability

Figures 3 to 5 provide an example of the initial analysis of the sustainability of locations in the study area, based loosely on criteria specified in the recently revised BREEAM criteria. Figure 5 shows that only a relatively small area of Bath would achieve the highest number of credits for sustainability, based on the 'service area' of the train station and bus stops. Offices existing outside of this area would be assumed less sustainable, or perhaps unsustainable. However, this is only indicative based on initial outputs of the analysis, using road network data and not including service frequency data. To assess sustainability, accessibility indices need to be created for individual office locations (Section 6.3), in order that the full criteria specified in the guidance can be used. Once complete, a thorough evaluation of the sustainability of areas will be made.

Initial gravity modelling assessment shows which urban areas in the study area perform better than others in terms of sustainable accessibility. Figure 6 shows that some peripheral urban areas such as Weston-Super-Mare actually perform better than would be expected of their location based on good public transport provision and service/facility availability. Areas such as Portishead actually perform worse than expected, and this is due to the absence of a railway station as this location. This method could be used to identify regional issues of peripherality and poor transport/service provision.

Accessibility of office buildings was initially mapped according to RPG10. This indicated that 16.4% of office buildings in the Bristol city-region meet the public transport accessibility criteria outlined in the Regional Planning Guidance (only 15.7% in the Bristol city urban area) (Figure 7) and that 55% offices are located in areas with the highest density (quartile) of services and facilities (Figure 8). The analysis shows that the criteria set out in RPG10 are very rarely met. 3726 of the 4420 offices in the Bristol urban area (84%) do not fall within even the maximum, let alone the target accessibility in terms of walking distance from a station and a bus stop. It must be noted that these criteria are not used in the replacement Regional Spatial Strategy for the region, perhaps suggesting they were not realistic. It is also noted that this method differs from BREEAM by producing a 'yes' or 'no' answer to meeting targets, whereas BREEAM rates locations using a scale of accessibility (very poor to excellent) to assign sustainability criteria.

Accessibility indices are being created for all office buildings in the Bristol city-region according to criteria specified in BREEAM. Early results from the analysis suggest that a higher number of offices in the study area will achieve higher sustainability ratings, as the criteria are more lenient. In BREEAM, the maximum walking distances are higher, transport facilities are fewer and the chosen services are generally frequently located near most office clusters. As a result, urban locations receive high ratings. The current analysis uses recently available street network data, as opposed to the road network data used for initial analysis. This allows a more realistic assessment when analysing accessibility, as it includes additions such as pedestrian walkways, footbridges and other crossings.

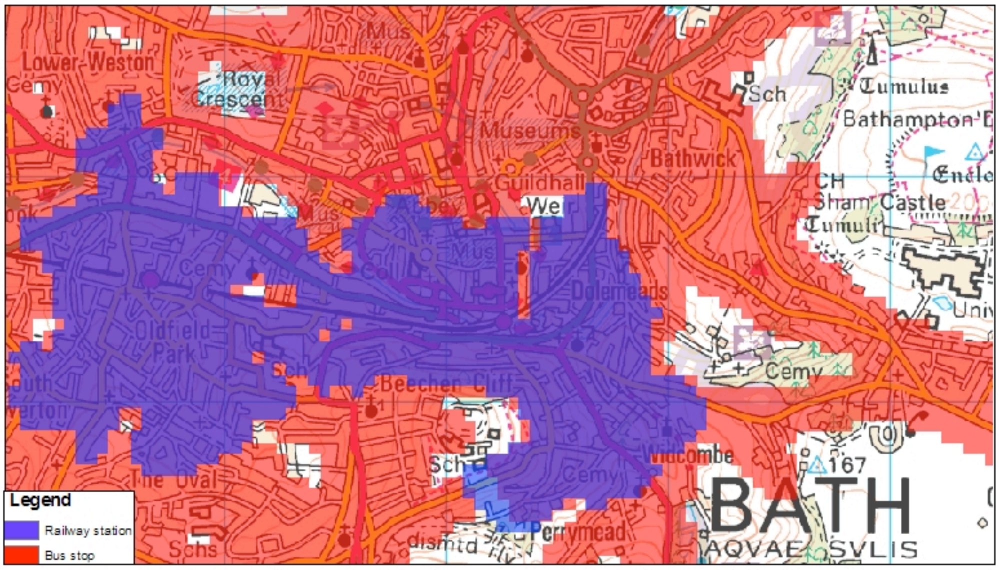


Figure 3. Accessibility to public transport in Bath, Somerset: areas within 1km of railway stations and 650m of bus stops (loosely based on BREEAM criteria)

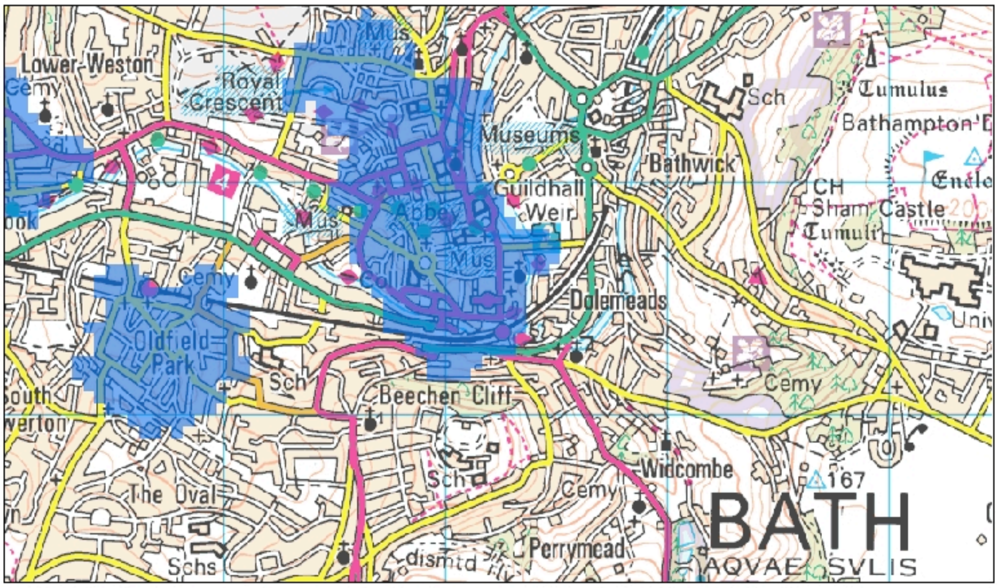


Figure 4. Accessibility to services and facilities in Bath, Somerset: areas within 500m of a food shop, cash point and Postbox (loosely based on BREEAM criteria)

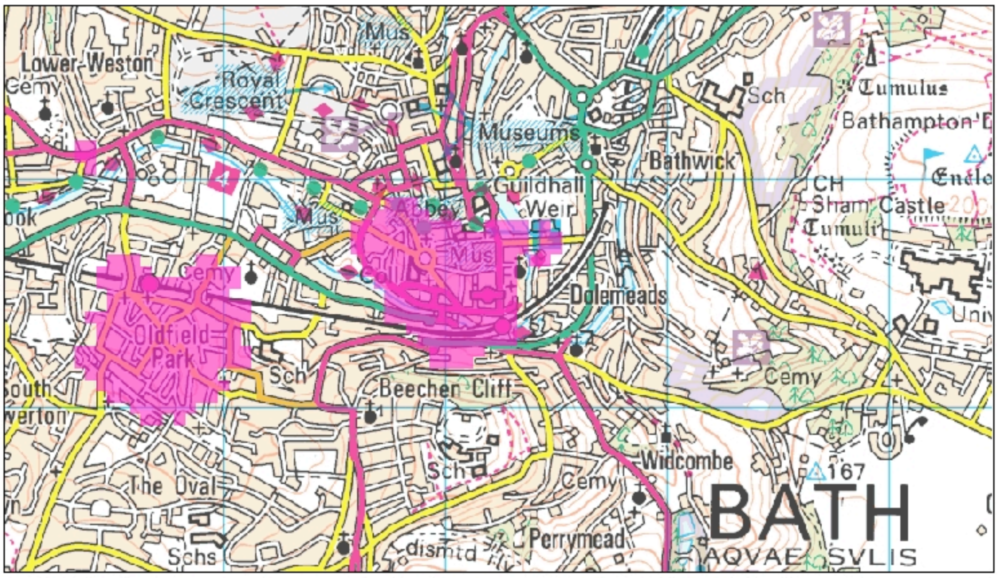


Figure 5. Most sustainable locations for offices in Bath, Somerset: combining the above transport and service accessibility maps (loosely based on BREEAM criteria)

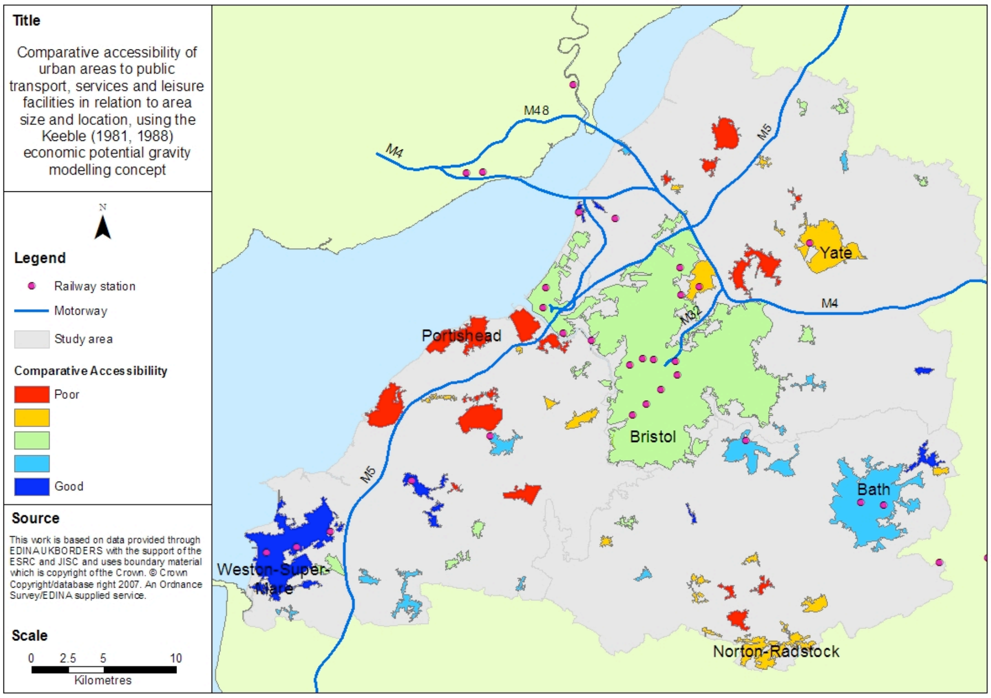


Figure 6. Analysis of the economic potential of urban areas weighted by availability of public transport, service and leisure facilities

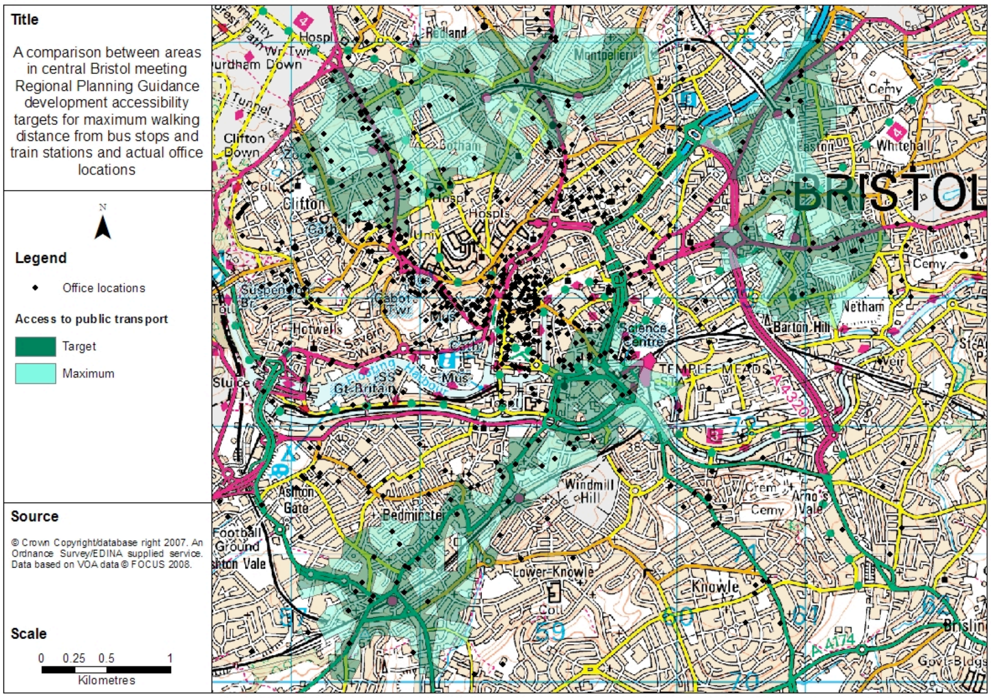


Figure 7. Analysis of accessibility to public transport in the Bristol area according to RPG10

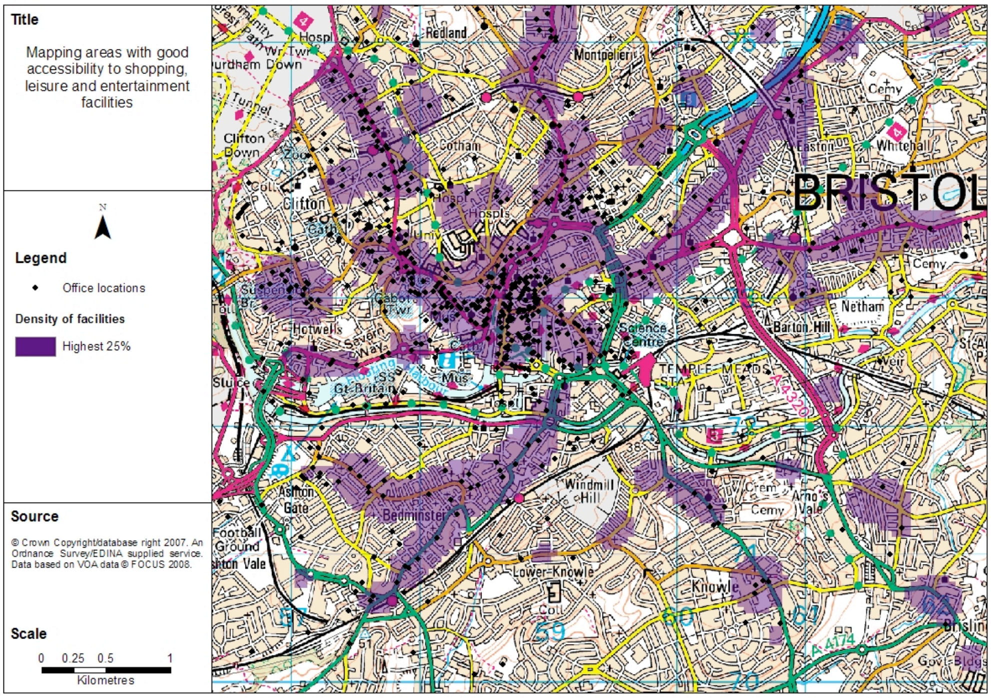


Figure 8. Analysis of accessibility to services and facilities in the Bristol area according to RPG10

7 Discussion and policy implications

A sustainable location for a SME is one that offers maximum accessibility and 'quality of life' related factors for the employees. Adding in the dimension of access to public transport provides a more sustainable location in the wider environmental context. SMEs may be choosing sustainable locations to an extent, as many businesses succeed and many of them are located in accessible locations with good levels of facilities and quality of life aspects for their employees. In the initial stages of business, a new start-up company prioritises cost as the main determinant of their own ability to sustain the business. As the company increases in size, staff quality of life becomes an important consideration. Environmental sustainability is often not a direct consideration, but by desiring to locate near to public transport connections for staff and client accessibility, these conditions may be fulfilled. Spatial analysis of office locations suggests that existing premises may not be in sustainable locations according to current guidance and many of the offices in the West of England are not 'accessible' particularly in relation to rail transport. Therefore businesses do not always have the choice of being in a sustainable location, especially as these locations may command high rents. This has policy implications and needs to be a key consideration in the creation and adaptation of buildings to be used as office premises.

Mapping the 'softer' factors of decision-making, such as 'quality of life' criteria, is complex. Crucially, it has been difficult to accurately reflect the criteria adopted by BREEAM on an area-wide scale. Also, the criteria used may not accurately reflect what is required by smaller businesses to enable their sustainability. This suggests that current methods for assessing sustainability may not be appropriate. The criteria used in existing sustainability assessment measures should be questioned, for example, in relation to the inclusion of Postboxes. It is included as one of three criteria to measure sustainability of office locations by BREEAM, but only one of the SMEs surveyed mentioned this as a criterion, suggesting that this may not be important to business. The survey revealed that a range of services and facilities are important to SMEs, so it may be more appropriate to use a measure estimating the density of services in general.

This analysis could be used to advise where additional infrastructure is required in terms of transport. This shows that offices are not located near sustainable transport therefore local level planning policies cannot get business to locate more sustainably as there simply are not the offices within these locations. Either more offices need to be built/extended in the accessible locations or the public transport infrastructure needs to be improved.

Although the analysis phase is still in progress, the research reveals that the heterogeneity of SMEs results in a more complex approach to decision-making than that of larger businesses. Following further analysis, results from the survey will help to shed light on where businesses want to locate and how important sustainable accessibility is to them.

The findings of this research have implications for future spatial planning policy, current sustainability assessment methods, encouraging the growth of small businesses, and preparing for sustainable growth in the future.

Upon completion of accessibility analysis using the street network, further stages of the research will include two additional components. Firstly, using the gravity model concept to consider actual employee locations to identify the optimum location for an office premises would be. This is based on the locations of the employees, factors quoted as important by businesses, using the road network and then a sustainable accessibility network. Secondly, correlation analysis will be carried out in order to compare rateable values of office locations with sustainability values to assess the relationship between quality of life, accessibility, sustainability and the value that the office commands.

8 Acknowledgements

This project is part of the Government-funded 'Great Western Research' initiative, and is a collaboration between the University of the West of England in Bristol, the University of Bath and a private geographic information business, Geofutures. Funding is from the South West Regional Development Agency (SWRDA), the University of the West of England and Geofutures.

9 References

Anderson, S E and Gansneder, B M (1995) Using Electronic Mail Surveys and Computer Monitored Data for Studying Computer Mediated Communication Systems, 'Social Science Computer Review', 13(1), pp. 33-46.

Bartholomew, S and Smith, A D (2006) Improving Survey Response Rates from Chief Executive Officers in Small Firms: The Importance of Social Networks. 'Entrepreneurship: Theory & Practice', 30(1), pp. 83-96.

Beyer, H L (2004) "Hawth's Analysis Tools for ArcGIS" [online]. Available: http://www.spatialecology.com/htools. Accessed 10 December 2008.

Building Research Establishment (BRE) (2008) "BREEAM Offices 2008 Assessor Manual". BRE Environmental & Sustainability Standard. BES 5055: Issue 1.0. BRE Global Limited.

Copus, A K (1999) "A New Peripherality Index for the NUTS III Regions of the European Union. A Report for the European Commission", Directorate General XVI.A.4 (Regional Policy and Cohesion). ERDF/FEDER Study 98/00/27/130.

Department for Business Enterprise and Regulatory Reform (BERR) (2008) "Small and Medium Enterprise Statistics 2007 for the UK and Regions. Enterprise Directorate" [online]. Available: http://stats.berr.gov.uk/ed/sme. Accessed 1 October 2008. Published 30 July 2008.

Dillman, D A (2000) "Mail and Internet surveys: the tailored design method". Second edition. New York: John Wiley & Sons, Inc.

European Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises (notified under document number C(2003) 1422) (Text with EEA relevance) (2003/361/EC).

Green, R (2005) Creating a sustainable city region. In: Jenks, M and Dempsey, N (Eds) "Future forms and design for sustainable cities". Oxford: Architectural Press, pp. 95.

GVA Grimley (2006) "Survey of Property Trends: 'Green' Issues", Summer 2006.

Jordans Limited (2007) "Financial Analysis Made Easy (FAME): UK and Irish company information in an instant", Bureau van Dijk Electronic Publishing (BvDEP) [online]. Available: https://fame.bvdep.com/version-2008215/cgi/template.dll?product=1. Accessed 15 January 2008.

Keeble, D, Owens, P L and Thompson, C (1981) "The Influence of Peripheral and Central Locations on the Relative Development of Regions". Department of Geography, Cambridge University.

Lewis, K, Massey, C and Harris, C (2007) Learning by doing: six dimensions of complexity in researching SMEs. 'Qualitative Research in Accounting & Management', 4(2), pp. 151-163.

Office for National Statistics (ONS) (2007) "Introduction to the 2001-based Travel-to-Work Areas". Newport: ONS.

Office for the Deputy Prime Minister (ODPM) (2004) "Planning Policy Statement 12: Local Development Documents". London: TSO.

OpenStreetMap (2009) "The Free Wiki World Map" [online]. Available: www.openstreetmap.org. Accessed 18 February 2009.

Pitot, M, Yigitcanlar, T, Sipe, N and Evans, R (2006) The land use and public transport accessibility index model. International Geographical Union 2006 Brisbane Conference, 3 - 7 Jul 2006, Queensland University of Technology, Brisbane [online]. Available: http://www.sortclearinghouse.info/access/detail.php?x0=title:%22Land%20Use%20and%20Public%20Transport%20Accessibility%20Index%20(LUPTAI)%20tool:%20the%20development%20and%20pilot%20application%20of%20LUPTAI%20for%20the%20Gold%20Coast%22&&locale=en-us&connection=sort.monash.edu.au:8080&view=SORT&number=15&r0=title&director=sort.monash.edu.au:8080&group=format&sort=date&order=desc&start=1&pid=sort:59&director=: Accessed 15 December 2008.

Ravetz, J (2000) "City Region 2020: Integrated Planning for a Sustainable Environment". London: Earthscan Publications Ltd

Sayce, S and Ellison, L (2003) Integrating sustainability into the appraisal of property worth: identifying appropriate indicators of sustainability. The American Real Estate and Urban Economics Association Conference, RICS Foundation Sustainable Development Session. August 21-23, 2003, Skye, Scotland [online]. Available: http://www.sustainableproperty.ac.uk/sustainability-papers.htm. Accessed 18 April 2007.

Sayce, S and Ellison, L (2004) "Towards sustainability indicators for commercial property occupiers and investors" [online]. Available: http://www.sustainableproperty.ac.uk/sustainability-papers.htm. Accessed 18 April 2007.

Sayce, S, Ellison, L and Smith, J (2004) Incorporating sustainability in commercial property appraisal: evidence from the UK, The 11th European Real Estate Society Conference, 2-5 June 2004, Milan, Italy [online]. Available: http://www.sustainableproperty.ac.uk/sustainability-papers.htm. Accessed 18 April 2007.

Stead, D (2000) Unsustainable settlements. In: Barton, H (Ed) "Sustainable communities: the potential for eco-neighbourhoods". London: Earthscan Publications Ltd

South West of England Regional Development Agency (SWRDA) (2006) "Regional Economic Strategy for South West England 2006 - 2015". Pontypool: Mwl Print Group.

Thales (2009) "National Public Transport Data Repository (NPTDR)", operated on behalf of the Department for Transport [online]. Available: www.nptdr.org.uk. Accessed 10 February 2009.

Tomaskovic-Devey, D, Leiter, J and Thompson, S (1994) Organizational Survey Nonresponse. 'Administrative Science Quarterly', 39(3), pp. 439-457.

Townsend, A and Tully, J (2004) "Cities, city regions and the changing geography of business offices". Report for the Office of the Deputy Prime Minister. International Centre for Regeneration & Development Studies, University of Durham, September 2004.

Transport for London (2006) "Transport assessment best practice: guidance document". May 2006 [online]. Available: http://www.tfl.gov.uk/corporate/about-tfl/publications/1482.aspx. Accessed 20 August 2008.

Application of analytic network process to assess risks in urban regeneration projects

Dr Zhen Chen, Sukulpat Khumpaisal

Liverpool John Moores University, UK

A result of ignoring the potentially adverse consequences of risks may be to compromise the progress and profit of an urban regeneration project. The main purpose of this paper is to provide a review of decision-making procedures which are demonstratively effective in providing practitioners with the method of assessing the potential risks involved in urban regeneration projects. Traditional risk assessment methodology depends on information from panel/board discussions rather than on numerical or statistical data. This leads to practical difficulties in systematising the assessments. In this paper we introduce a multi-criteria approach, which is based on the theoretical framework of Analytic Network Process (ANP) theory.

The paper commences with an introduction to the risks commonly occurring in urban regeneration projects and the suggestion that ANP is an appropriate tool for the assessment of those risks. In order to assess the risks involved in urban regeneration projects effectively, a group of assessment criteria is defined, based on the Social, Technological, Economic, Environment and Political (STEEP) concerns of the practitioners. In addition to these criteria, an over-arching commitment to sustainable development has also been assumed. These assumptions are applied in an experimental case study of a residential and commercial mixed-use project in Liverpool City Centre to demonstrate the effectiveness of the ANP model. However, due to limitations of time, the researchers are not able to forecast the feedback or calculate the final outcome of the ANP process, nor did they have adequate case studies to supply more accurate field data. In conclusion, the result of an experimental case study suggests that ANP is an effective tool to support developers in the assessment of the potential risks associated with urban regeneration projects.

Keywords: Analytic Network Process, STEEP Factors, risk assessment, urban regeneration

1 Introduction

1.1 Risks in urban regeneration projects

Risks and uncertainties always caused in urban regeneration projects, particularly in the complicated urban regeneration projects involved with public and community interest as well as the potential stakeholders. Risks also cause crucial adversities to overall urban regeneration project progression and profit, in which those will strongly affect to each urban regeneration project stages from the project conceptual, project feasibility analysis, design and planning, construction and execution, till the public usage. Existing risk management process are generally involve an ongoing and iterative process each project being in some respect unique. Clarke and Varma, (1999) and Flyvbjerg, (2003) define that the typical risk management process is an ongoing and iterative, even each urban regeneration project is different and unique, but a typical approach of risk management is containing with four basic steps, as risk identification and initial assessment; risk analysis, risk assessment and risk mitigation (see figure 1)

In this regard, each urban regeneration project normally has its own objectives to achieve if it is to be deemed successful. The typical achievements of an urban regeneration project could be summarised as:

- Resources are efficiency used and waste is minimised by closing cycles;
- Pollution is limited to levels which natural systems can cope with without damage;
- The diversity of nature is valued and protected;
- Everyone has the opportunity to undertake satisfying work in a diverse economy. The value of unpaid work is recognised whilst payments for work are fair and fairly distributed;
- People's good health is protected by creating safe, clean, pleasant environments and health services which emphasise prevention of illness as well as proper care for the sick;
- Access to facilities, services, goods and other people is not achieved at the expense of the environment or limited to those with cars;
- Everyone has access to skills and knowledge

(Liverpool City Council 1997 as cited by Couch and Dennemann 2000)

Since it is in the nature of urban regeneration projects that they will impinge upon both the public (provider) interest and the community interest, a significant source of project risk my result from the failure of the providing organisation to communicate, involve and discuss with the host community the outcomes that the project is intended to achieve. (Atkinson 1999).

It is also the case that many urban regeneration projects fail on account of the perceived miss-match between what they are designed to offer and what the community actually needs.Many urban regeneration projects were failed, due to an imbalance between new development and local community actually needs. Since most of urban regeneration projects strongly emphasise on the physical redevelopment of existing communities rather than concern of local community actual needs. For example, many cities now adapt the revitalization of the central business district and refurbishment of residential neighbourhoods to the city policies in regard to urban regeneration programmes and local community requirements, but the urban regeneration projects still evolved into a policy based less on destruction of the existing business and more on renovation and investment, and also combined with small and big business incentives from the real estate developers. Therefore, urban regeneration projects are still closely associated with risks caused by political issues such as protestant or group of activists, in addition, the number of jobs in the developed area would be varied in accordance with the size and duration of project as well.

New urban development projects will also impact significantly upon the existing real estate market. The values of all real property interests in the area may be affected either positively or negatively by the introduction of the project of urban regeneration nearby. Such changes may prompt alterations in the scale, location and intensity of the activities of real estate developers which will themselves require the intermediation of the planning / permit system to ensure that community sensitive development results from the change. For example, the selling or rental price of the existing properties would be fluctuated by the influence of selling/ rental of a new developed project (Jones and Watkins, 1996).

Thus the risks inherent in urban regeneration projects could be summarised in accordance with Social, Technological, Economic, Environmental and Political factors or "STEEP" factors (Morrison 2007; Gehner et al. 2006 and Clarke and Varma, 1999). For example, risks in urban regeneration project have been considered, in relation to the separation of design from construction, lack of integration between planners and community, poor communication to the local community, uncertainty, changing environment and increasing project complexity and economic changes such as inflation and deflation, regional economic crises including an imbalance between new development and social actual needs. Hence, risks and their consequence of risks caused by STEEP factors, must be considered and should not be underestimated, since those risks will impact overall project management processes, in regard to project programme delay, protest by activists and community leaders.

According to the aforementioned characteristics of urban regeneration projects, these projects may result in the destruction of businesses, the relocation of people, and the use of compulsory purchase as a legal instrument to reclaim private property for city-initiated development projects. Therefore, it could be concluded that risks in urban regeneration project are mostly associated with the public interest, city harmonisation and local community involvement. This paper will emphatically focus on the risks, which are necessary to be concerned when planners conduct the project feasibility analysis, because of feasibility analysis is a significant tool in regard to forecast uncertainties as well as to assess the vitality of an urban regeneration project.

1.2 Current existing risk assessment methods

The results of IPF survey in UK real estate industry (2007) support that risks associated with real estate or properties industry could be coped with an overall framework or risk management processes, those risks shall apply a variety of complimentary approaches, which are grounded in a rigorous and preferably quantitative framework. The ideal risk management processes shall include an assorted mix of "Quantitative statistical framework" as well as several techniques such as stress testing and a rigorous analysis of subjective issue. In order to assess risks and their consequences, it is suggested to use the practical tool, which could analyse risks, their consequences and computed the results in a numerical format. The desirable methodology for the real business should allow for the synthesis of the criterion, comparisons of each factors and to help the practitioners to structure the decision making process (Booth et al. 2002), and thus, risk assessment process in the real estate development shall be supported by the modern method of mathematical statistics (Titarenko 1997).

The popular risk analysis method named "Risk Matrix", is generally accepted by many business as the practical risk assessment tool to assess the consequence of risks (Kindinger 2002 and ioMosaic 2002). This method also accepted particularly in many property development projects, for example the investment of hotels. (Younes and Kett 2007) However, the data used for matrix calculation derived from either a panel discussion or ranking method, which mostly rely on personal opinion rather than using quantitative measurements, and do not use reliable tools or instruments with strong theoretical basis. (Please see Figure 1 ANP and Existing Risk Assessment Model) Other inconvenience is that the risk matrix does not allow the comparison of each criteria, and results calculated by matrix are normally subjective, do not provide the detail of data to help the developers to structure their decision- making process. This is because risk factors are numerous, particularly in large urban regeneration projects, and the ability of humans to assess many factors at the same time is very limited (He 1995).

1.3 Contributions of Analytic Network Process (ANP) to urban regeneration projects

According to the aforementioned problems in this scheme, the urban planners require an effective risk assessment tools to assess the potential risks associated in the urban regeneration projects. Therefore, the comprehensive risk assessment criteria for the urban regeneration projects and the decision-making / supporting model will be established in this paper(Section Four). The criteria will focus on risks associated in urban regeneration projects based on STEEP factors, and consist of the evaluation methods for each sub-criterion. The thorough analysis of risks in urban regeneration by using quantitative analysis method and will be respectively conducted in this paper.

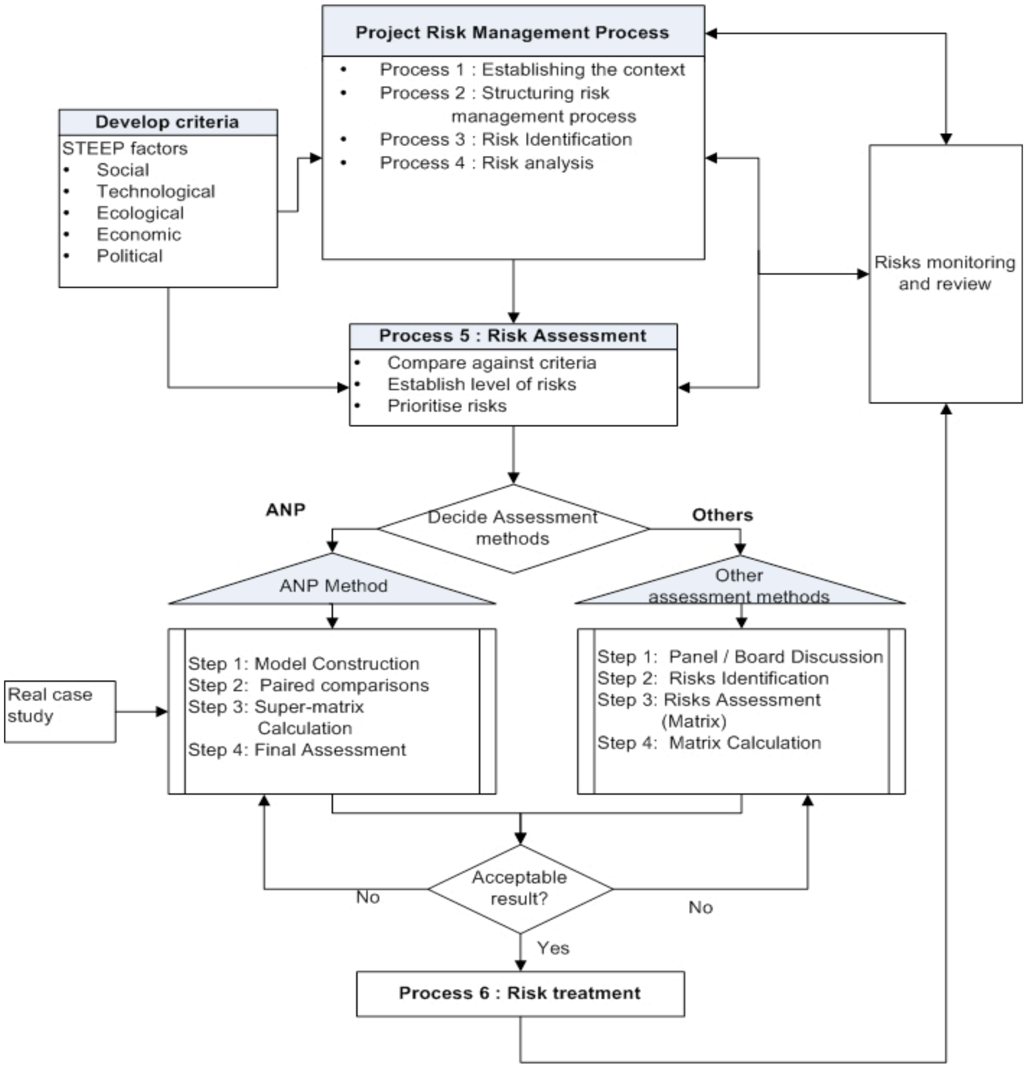
An application of ANP model to support the decision-making approach to risk assessment in urban regeneration projects against STEEP factors will be introduced in this paper. To pursue the requirements of ANP, risk criteria have been modified to suit with the planners and practitioners' requirement in regard to assess the potential risks involved in urban regeneration project. This ANP model is the systematic approach, which deal with both quantitative and qualitative factors under multiple criteria (Saaty 2005). ANP processes actually deal with a multi criterion analysis and comparison, the outcome of ANP calculation will in a mathematic statistic format, which enables further decision making in regard to the risk response and mitigation. This study is supported by using an urban regeneration project in Liverpool City centre to demonstrate the effectiveness of this Analytic Network Process (ANP) model.

2 Methodology

The methodology adopted in this research consists of literature review, a questionnaire survey which including an interview with experts in urban planning or regeneration area to gain information in regard to current situation in risks assessment for urban regeneration projects, following by the data analysis to support ANP model, and case study to demonstrate the effectiveness of ANP model to support decision-making prior the regeneration project commences. According to our extensive literature review, a risk management process, and a comparison between the existing risk assessment methods and ANP model could be summarised by a figure 1: Risk management process and a selection of risk assessment method.

Figure 1 illustrates entire risk management process including a selection of risk assessment method, it was adapted from AS/NZS 4360: 2004 risk management standard. Whether traditional or ANP assessment models selected in urban regeneration project, risk management process normally commences by establishing the contexts (process 1), which are strategic, organisational and further risk management contexts, but those will depend on the characteristics of a specific project and the preference of decision-makers. Then, the decision-makers have to set up the entire risk management structure (process 2), which collaborate with the factors of risks, which associated with STEEP factors. Risks identification (process 3) is therefore conducted in order to clarify the affects of risks as well as to identify sources of risks. Then, risk analysis (process 4) shall be undertaken to determine risks controlling methods as well as to determine the likelihood and the consequence of each risk affect to the project.

Risk assessment (process 5) is conducted to compare risks against the established criteria, as well as level the consequences of each risk and prioritise the significant of each risk, before the risk mitigation can be taken place. In this process, the decision-makers will select the appropriate method, whether the existing risk assessment methods (in this regard, the existing is a Risk Matrix) or Analytic Network Process (ANP). In the case of using traditional method, the decision-makers have to conduct a panel/board discussion about the risks and the consequences of those risks, while each participants use their experience to identify or classify predictable risk events. Following by the assessment method set up, in the current practice, it is most likely to create a risk assessment matrix (RAM). RAM method, is generally accepted by many decision-makers, as the practical tool to assess the likelihood and the consequence of risks (ioMosaic, 2002; Kindinger, 2002; Rafele, et al, 2005). It describes the likelihood and consequence of each risk in a tabular format. As a result of risk matrix, the panel can degree overall risk events. This method is simply in using, and it is also easy for laypersons to understand. However, the results derived by matrix assessment method are not based on either non-linear mathematic calculation or objective assumptions related to a real business case, as well as it does not allow the comparisons amongst each criteria. The results calculated by matrix are normally subjective, do not provide the detail of data to help the decision makers to structure their decision- making process. Since the risk factors are numerous and complicate, particularly in large urban regeneration projects, while humans are limit to assess many factors at the same time (He, 1995).



Source : AS/NZS 4360: 2004 risk management standard (ACT 2004)

Figure 1: Risk management process and a selection of risk assessment method

Alternatively, in the case where ANP process has been selected, the first step is to develop an ANP model, follows by pair-wise comparison process to form a super-matrix of quantified interdependences between paired criteria and the alternatives of development plan. The results calculated by super-matrix calculation can suit the project team in order to get a numerical suggestion regarding to the most appropriate development plan. The result from ANP is useful to support the decision-making process toward the project risk mitigation. In addition, a project knowledgebase is required to be integrated into the process for using either traditional method or ANP method, in order to complete decision-making tasks. The knowledgebase provides the adequate and accurate information to achieve reliable results, and the knowledge can be collected from existing or new urban regeneration projects.

2.1 Risk assessment criteria

Prior to the commencement of a thorough calculation by ANP, risk assessment criteria, laying emphasis on the risks and their consequence to the urban regeneration project are established, based on a literature review and on the researchers' experience. These assessment criteria are set up in accordance with the content of Social, Technological, Economic, Environmental and Political factors (STEEP), as well as against the sustainable development requirements. The criteria are necessary, when the urban planners conducting a project studying analysis before a construction or execution process commence. Variety of risks is covered by the content of STEEP factors throughout every urban regeneration projects stage from conceptual, feasibility analysis, design and planning, construction till using of the project. In this regard, the assessment criteria and the evaluation method of each sub-criterion are summarized in the Table 1, this table classifies overall on both quantitative and subjective risks. In addition, it is adopted as the assessment criteria to measure the risks and their impact to the urban regeneration projects, prior to the Analytic Network Process (ANP) analysis. This table includes five major criteria and their 30 sub-criteria (please see the Table 1: Risks Assessment Criteria for the urban regeneration projects)

Table 1: Risks Assessment Criteria for the urban regeneration projects

Criteria	Sub-Criteria	Valuation methods	Representative references
Social risks	Community acceptability	Degree of benefits for local communities (%)	Danter, 2007
	Community's participant	Degree of discourse of partnership and empowerment to community	Atkinson, 1999
	Cultural compatibility	Degree of business & lifestyle harmony (%)	Danter, 2007
	Public hygiene	Degree of impacts to local public health & safety (%)	NHS Standards
	Social Needs for new development	Degree of balancing between physical development and social need (%)	Jones and Watkins, 1996
	Workforce availability	Degree of Developer's satisfaction to local workforce market (%)	Danter, 2007
Technological risks	Accessibility & Evacuation	Degree of easy access and quick emergency evacuation in use (%)	Moss, et al., 2007
	Amendments	Possibility of amendments in design and construction (%)	Khalafallah, et al., 2002
	Constructability	Degree of technical difficulties in construction (%)	Khalafallah, et al., 2002
	Duration of development	Total duration of design and construction per 1,000 days (%)	Khalafallah, et al., 2002
	Durability	Probability of refurbishment requirements during buildings lifecycle (%)	Chen, 2007
	Facilities management	Degree of complexities in facilities management (%)	Moss, et al., 2007
	Transportation's convenience	Degree of public satisfaction to transportation services after new development (%)	Couch & Dennemann, 2000
Environmental risks	Adverse environment impacts	Overall value of the Environmental Impacts Index	Chen, et al., 2005
	Land contamination	Price of the contaminated land plot	CERCLA, 2000
	Pollution during development	Degree of pollution affect to the local community	Healey, 1990
	Site conditions	Degree of difficulties in site preparation for each specific plan (%)	Danter, 2007

Table 1 (continued)

Criteria	Sub-Criteria	Valuation methods	Representative references
Economic risks	Area accessibility	Degree of regional infrastructures usability (%)	Adair & Hutchison, 2005
	Capital exposure	Rate of estimated lifecycle cost per 1 billion pound (%)	Blundell, et al., 2005; Moore, 2006
	Capital value	Sale records of new developed properties	Jones & Watkins, 1996
	Demand and Supply	Degree of regional competitiveness (%)	Adair & Hutchison, 2005
	Development fund	Amount and sources of funding injected to urban regeneration project	Adair, et al., 2000
	Job creation	Numbers of Jobs created and loss during urban regeneration	Jones & Watkins, 1996
	Lifecycle value	5-year property depreciation rate (%)	Lee, 2002; Adair & Hutchison, 2005
	Market rental	Rental rate of properties in the new development area	Jones & Watkins, 1996
	Property type	Degree of location concentration (%)	Adair & Hutchison, 2005; IPF, 2007
	Purchaseability	Degree of affordability to the same kind of properties (%)	Adair & Hutchison, 2005
Political Risks	Council approval	Total Days of construction, design approval process by Liverpool City Council (LCC)	Crown, 2008
	Local development policy	Degree of the contrast of the new development to existing local development policy (%)	LCC, 2008
	Political groups/ activist	Degree of protest by the urban communities (%)	Arthurson, 2001

3 APPLICATION OF ANALYIC NETWORK PROCESS (ANP)

3.1 Analytic Network Process (ANP) model

The decision-making model proposed in this paper applies ANP to set up the risk assessment at project feasibility study stage. According to the established risks assessment criteria in Table 1, the ANP model herein based on these 30 defined risk assessment criteria. The model is set up using Super Decisions software for decision-making, created by the Creative Decisions Foundation; and implemented by Professor Thomas Saaty (2005). ANP model comprises 6 clusters and 30 nodes, which are set up accordingly to the criteria and sub-criteria defined in Table 1. The Alternative cluster is used to comprehend alternative plans to be evaluated against risk assessment criteria in a case study; and there are 2 nodes to represent 2 alternative plans for a specific real estate development. ANP method provides an effective mechanism for developers to quantitatively evaluate interrelations between either paired criteria or paired sub-criteria; and this enables the practitioners to adjust their opinions and expertises to assess the consequences of all defined risks (see Table 1) occurred in the urban generation project.

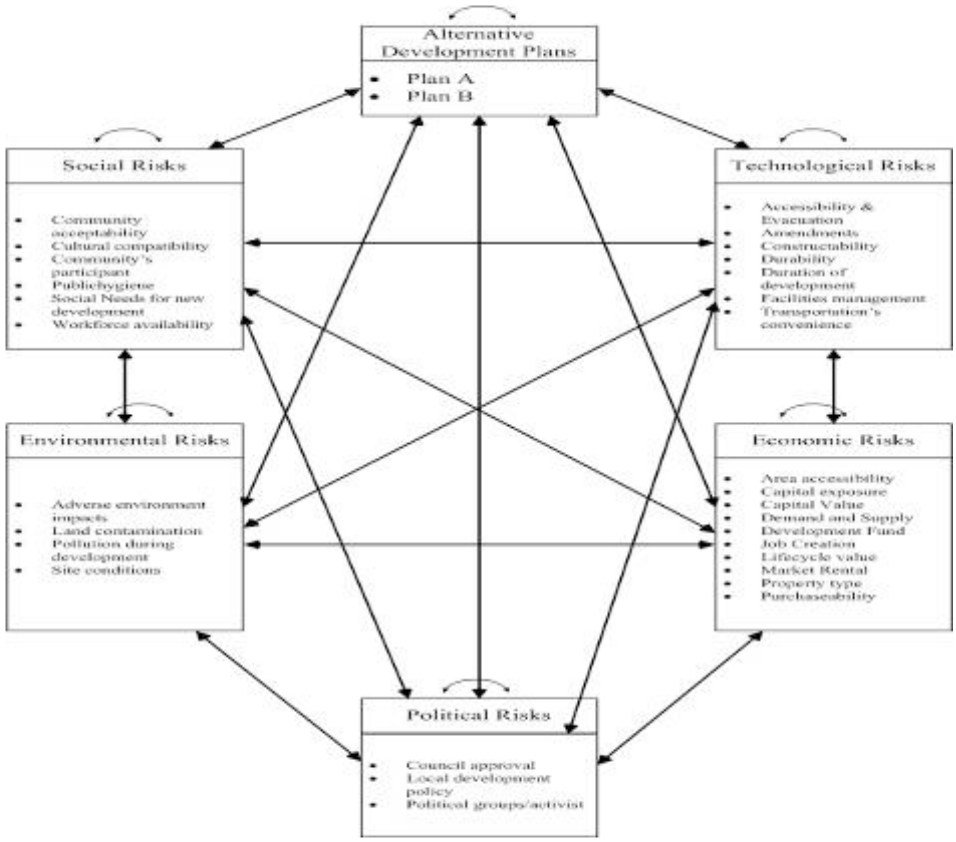


Figure 1 ANP Model for the urban regeneration projects risk assessment

The ANP model, as represented in Figure 2, consists of six clusters which are Alternatives, Environmental Risks, Social Risks, Economic Risks, and Technological Risks. There are 32 nodes inside this ANP model; amongst them, there are 2 nodes inside the Alternative cluster, that are Plan A, and Plan B which represent alternative plans for a specific real estate development in Liverpool, in regard to select the most appropriate plan. The other 30 nodes are located in differenced 5 clusters in accordance with their belongingness to those clusters as described in Table 1. Two-way and looped arrow lines in Figure 1 describe the interdependences that exist between paired clusters as well as nodes (Saaty 2005 as cited by Chen & Khumpaisal 2008). In addition, there are fixed interrelations between paired clusters, meanwhile there are fixed interrelations between paired nodes inside one cluster as well as from two different clusters.

In order to measure all interrelations inside the ANP model quantitatively, the questionnaire survey to compare the relative importance between paired clusters and nodes is required to collect the precise information from the real estate practitioners. According to the questionnaire survey, the experts' knowledge and information in each specific domain is collected and concentrated into an ANP model as a result, the ANP model can perform as a decision-making support tool based on knowledge reuse. In this paper, the ANP model is set up by the authors only; and the model will be further developed based on questionnaire survey after a pilot study through the experimental case study.

3.2 A pair-wised comparison of each sub-criteria

The ANP model as illustrated in Figure 1, structuring and quantifying all possible interdependent relations inside the model, pair-wise comparison is adopted using subjective judgements made in regard to fundamental scale of pair-wise judgments (Saaty 2005) (please see Table 2: ANP Judgements between paired clusters/nodes). Table 2 generally describes how to conduct pair-wise comparison between paired clusters as well as nodes in regard to their interdependences defined in the ANP model (please see Figure 1) and relative importance based on their specific characteristics and experts' knowledge. The ANP model is set up based on the risks assessment criteria to make judgments to quantify interdependences for 30 risk assessment criteria inside cluster 2 to 6 (please see Figure 1), and specific characteristics of alternative plans, which used to make judgments in quantifying interdependences for alternatives in the experimental case study.

Clusters/Nodes		Scale of pair-wise comparisons								
		±1	±2	±3	±4	±5	±6	±7	±8	±9
Cluster I	Cluster J	×	×	×	×	×	✓	×	×	×
Node Ii	Node Jj	×	×	×	×	×	✓	×	×	×

Note:

The fundamental scale of pair-wise judgments: 1= Not important, 2= not to moderately important, 3= Moderately important, 4= Moderately to strongly important, 5= Strongly important, 6= Strongly to very strongly important, 7= Very strongly important, 8= Very strongly to extremely important, 9= Extremely important.

The symbol × denotes item under selection for pair-wise judgment, and the symbol ✓ denotes selected pair-wise judgment.

I and J denote the number of Clusters, whilst i and j denote the total number of Nodes.

The symbol ± denotes importance initiative between compared Nodes or Clusters.

Note : To pursue the requirements of ANP in regard to the pair-wised comparison, we has assumed the alternative regeneration plans as the option for calculating. The alternative plans are assumed that: PLAN A represents Retail–led mixed-use inner Liverpool City Centre, while PLAN B represents Commercial building led mixed-use adjacent to inner Liverpool City Centre.

4 Case study

To demonstrate the effectiveness of ANP to assess risks in urban regeneration project, a case study of a residential and commercial mixed-used project in Liverpool city centre is used in order to select the most appropriate plan for a specific real estate development project, which also less affect to overall community. A case study is conducted based on information collected from an ongoing real estate development project in Liverpool City Centre. Some scenarios such as alternative plans are made as the assumption of the study, in regard to fulfil the requirements of comparison between each cluster.

The proposed real estate development locates in central Liverpool with the site area of 40 acres, located between main retail areas, city central business district (CBD), residential areas, walk streets, main roads, and the historical Albert Dock. The Developer partnering with the City Council to revitalise this area for long-term investment in accordance with the Northwest regional and Merseyside County's economic strategies. To complete the experimental case study purposes, two development plans are considered in this research, which are: Plan A, a retail-led mixed-use inner Liverpool City Centre development; Plan B, a commercial building mixed-use adjacent to inner Liverpool City Centre development. The scenario assumed based on the philosophy of local urban regeneration, which aims to attract more population and customers back to Liverpool City Centre, as well as to maximum utilize of the provided transportation and infrastructures (Mynors 2006). The authors employed the face-to-face interview, facilitating by structure questionnaires with the practitioners who experienced the urban regeneration projects as well as expert in planning and development scheme in order to gain opinions and judgements in regard to the consequential degree of risks affected to his project. These results are indicated in Table 3: Results of face-to-face questionnaire survey.

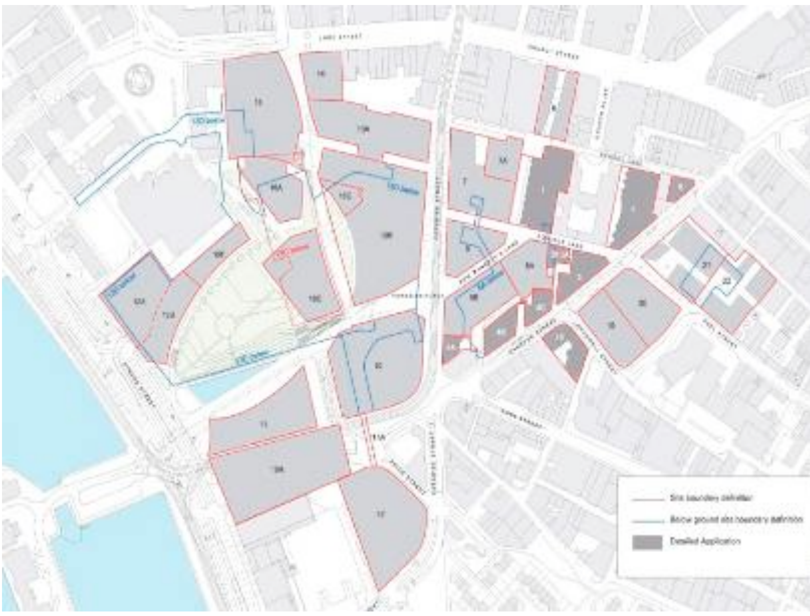


Image courtesy by Grosvenor, 2008

Figure 2: The layout plan of the Experimental case study

Table 3: Results of face-to-face questionnaire survey

Criteria	No.	Sub-Criteria	Unit	Participant 1		Participant 2		Participant 3		Weighted Quality Score	
				Plan A	Plan B	Plan A	Plan B	Plan A	Plan B	Plan A	Plan B
Social Risks	1	Community acceptability	%	25	25	50	50	30	40	32	35
	2	Community's participant	%	75	75	30	60	30	50	53	65
	3	Cultural compatibility	%	25	25	30	70	40	30	31	36
	4	Public hygiene	%	15	15	80	50	50	30	39	27
	5	Social Needs for new development	%	25	35	70	30	20	40	33	36
	6	Workforce availability	%	25	35	20	60	30	60	26	48
Technological Risks	7	Accessibility & Evacuation	%	15	15	50	50	30	30	27	27
	8	Amendments	%	25	25	70	50	40	30	39	32
	9	Constructability	%	25	35	20	70	30	50	26	47
	10	Duration of development	%	25	35	20	80	50	30	32	43
	11	Durability	%	25	35	20	60	50	30	32	39
	12	Facilities management	%	35	25	70	50	50	30	47	32
	13	Transportation's convenience	%	50	50	70	40	50	40	54	45
Environmental Risks	14	Adverse environment impacts	%	50	40	60	40	60	40	55	40
	15	Land contamination	%	25	25	70	50	60	30	45	32
	16	Pollution during development	%	25	25	50	50	60	20	41	29
	17	Site conditions	%	25	25	70	50	30	50	36	38

Table 3 (Continued)

Criteria	No.	Sub-Criteria	Unit	Participant 1		Participant 2		Participant 3		Weighted Quality Score	
				Plan A	Plan B	Plan A	Plan B	Plan A	Plan B	Plan A	Plan B
Economic Risks	18	Area accessibility	%	40	30	70	50	60	30	52	34
	19	Capital exposure	%	40	40	80	50	50	30	51	39
	20	Capital value	%	35	45	50	70	30	50	37	52
	21	Demand and Supply	%	35	45	70	40	50	30	47	40
	22	Development fund	%	25	35	40	70	30	60	30	50
	23	Job creation	%	25	35	20	60	40	30	29	39
	24	Lifecycle value	%	40	40	80	40	50	20	51	34
	25	Market rental	%	25	35	30	60	50	30	34	39
	26	Property type	%	25	35	40	60	40	60	33	48
	27	Purchaseability	%	25	35	50	50	60	40	41	40
Political Risks	28	Council approval	%	20	30	70	50	30	60	33	43
	29	Local development policy	%	20	30	40	60	30	50	27	42
	30	Political groups/activist	%	25	35	70	40	30	50	36	41

4.1 Adjustments of participants' opinions

As indicated in the Table 3: Results of face-to-face questionnaire survey, the results gained from interviewing with each participant are significantly distinguish, those are because of each participant's experience and background, their professional in urban planning scheme and their information in regard to the case study. To accomplish ANP pair-wise and super-matrix comparison of each node, the authors employed the Weighted Quality Score (WQS) method to adjust most appropriated percentage to be input into ANP calculation. In this regard, the results achieved by WQS are derived by the following equation.

$$V_{ij} = \sum_{k=3}^{n} W_{ijk} \; V_{ij\,k} \qquad (1)$$

Whereas

- V_{ij} is the value of each sub-criteria calculated by WQS
- W_{ikj} is the weighted of score for each sub-criteria given by participants k
- V_{ijk} is the value of each sub-criteria i for alternative j
- i is the sequential number of sub-criteria (i = 1,2, 3,…..,30)
- j is the code of alternative plan (j = A, B)
- k is the code of participants (k = 1, 2, and 3)
- n is the total number of participants in this paper (n = 3)

Additionally, each participant were weighted by the different ratio as we given 50% for Participant 1, 20% for Participant 2 and 30% for Participant 3, respectively. The reasons behind those adjusted weight are because of Participant 1 is a Liverpool local resident and also has the strong background and experience in urban generation project, as well as familiar with United Kingdom's urban development context, Participant 2 is an expert urban planner, but residing outside UK Northwest area and does not familiar with UK's context, whilst Participant 3 is a real estate development practitioner, but currently staying in Liverpool City Centre and familiar with the case study area. According to WQS calculation and supporting reasons mentioned above, the results derived by this method will be therefore input into ANP calculation to investigate for the most appropriate development alternative plan. (please refer to column "Weighted Quality Score" in Table 3)

Although the interdependences variable among 30 risk assessment criteria can be measured based on experts' knowledge, the ANP model should comprehend all specific characteristics of each alternative plan, which are given in Table 4. According to the fundamental scale of pair-wise judgments (see Table 2), all possible interdependences between each alternative plan and each risk assessment criterion, and between paired risk assessment criteria in regard to each alternative plan are valuated; Table 2 also provides the result of all these pair-wise comparisons, which used to form a two-dimensional super-matrix for further calculation. The calculation of super-matrix aims to form a synthesized super-matrix to allow for resolution of the effects of the interdependences exist between the nodes and the clusters of the ANP model (Saaty 2005 as cited by Chen and Khumpaisal 2008).

4.2 Results of the calculation

In order to obtain useful information for development plan selection, the calculation of super-matrix is conducted following three steps, which transform an initial super-matrix or un-weighted one based on pair-wise comparisons to a weighted super-matrix, and then to a synthesized super-matrix. Results from the synthesized super-matrix are given in Table 4: Comparison or Alternatives development plan results

Table 4 Comparison of Alternatives development plan results

Results	**Alternative Development Plans**	
	Plan A	**Plan B**
Synthesized priority weights	0.6283	0.3717
Ranking	1	2

According to the results shown in Table 4 Comparison of Alternative development plan results, Alternative plan A is identified as the appropriate plan for the specific development because it has the highest synthesized priority weight rather than Plan B alternative. The different between Plan A and B results indicates the likelihood of the developer to select the appropriate development plan based on results calculated by the ANP method. By the results above, it is suggested that the developer shall select Plan A as the project development plan of the studied project.

5 Conclusions and recommendations

An application of Analytic Network Process (ANP) in regarding to assess risks in urban regeneration project is introduced in this paper. Risk assessment criteria are set up in order to proceed the ANP calculation was based on literature review and the author's experiences including valuable opinions from experts in this field. All assessment criteria are summarised under STEEP factors theory, which could be categorised as: Social, Technological, Environmental, Economic and Political factors. Those factors shall be concerned by the planners and practitioners at the stage of project feasibility analysis prior the regeneration project commence.

To complete this research, An ANP model is therefore established based on the defined risks criteria associated with STEEP factors as well as against the sustainable development's requirements. We made an assumption that one of two alternative development plans would be suitable to develop in the Liverpool City centre area. There are 30 risks under five clusters, to ensure a comprehensive coverage of possible risks occurred in urban regeneration project. Then, face-to-face interview with 3 participants who expert in urban planning, urban regeneration project and real estate development has been conducted, in order to gain his/her expertise to make a comprehensive risk assessment model .

Additionally, based on the participants' opinions, they stated that the developers of the regeneration project must focus on risks associated with social and political factors, since this kind of project is usually involve with a local community and public interest. Thus, the new development must conform to the local development policy, as well as the developers have to balance between project's objectives and the actual needs of local community which also include community health and safety issues. In regard to the raw data as obtained from the urban regeneration experts, the criteria that mostly influence to urban regeneration projects is Community Participant, following by Transportation' s Convenience and Advert Environmental Impact, respectively. In this regard, it could be concluded that the developers of urban regeneration or real estate development projects need to concern in those such risks both prior a project start as well as during when the construction proceed.

According to the results which precisely calculated by ANP model, it summarise that the Alternative A "The retail-led mixed used property" shall be the appropriated development plan. On the other hand, this Plan A also affected by the consequence of risk higher that the Alternative B "The commercial building led mixed use".

With a reference to the results of face to face questionnaire survey calculated by ANP model, the valuable opinions from each practitioners, together with the precise data derived from ANP analysis model. It could be concluded that ANP is an effective tool to support the planners in decision-making in regarding to assess risks occurred in urban regeneration projects. The ANP model therefore can be adopted by urban planners or the practitioners if they require to assess risks in a complicated urban regeneration project. However, the further researches are required, since it needs a massive information from urban planners, experts and practitioners in the variety of regeneration projects to modify and improve the risk assessment model to suit with the developer requirements in order to improve more consistency and reliable to the risk assessment criteria.

6 References

ACT Insurance Authority (2004), Guide to risk management: AS/NZS 4360: 2004 risk management standard, Australian Capital Territory Insurance Authority

Adair, A, Berry, J, McGreal, S, Deddis, B and Hirst, S (2000), The financing of urban regeneration, 'Land Use Policy', volume 17, pp. 147-156

Adair, A, and Hutchison, N (2005), The reporting of risk in real estate appraisal property risk scoring, 'Journal of Property Investment and Finance', volume23, No.3, 254-268.

Arthurson, K (2001), Achieving Social Justice in Estate Regeneration: The Impact of Physical Image Construction, 'Housing Studies', volume 16, No.6, 807-826.

Atkinson, R (1999), Discourses of Partnership and Empowerment in Contemporary British Urban Regeneration, 'Urban Studies', volume 36, No. 1, 59-72

Blundell, G.F, Fairchild, S, and Goodchild, R N (2005), Managing Portfolio Risk in Real Estate, 'Journal of Property Research', volume22, No. 2&3, 119-136.

Booth, P, Matysiak, G and Ormerod, P (2002), "Risk Measurement & management for real estate portfolios", Investment Property Forum, London.

Chen, Z, Li, H and Wong, C.T.C (2005), Environmental Planning: an analytic network process model for environmentally conscious construction planning, 'Journal of Construction Engineering and Management', volume131, No.1, 92-101.

Chen, Z, Clements-Croome, D, Hong, J, Li, H and Xu, C (2006), A multicriteria lifespan energy efficiency approach to intelligent building assessment, 'Energy and Buildings', volume38, No. 5, 393-409.

Chen, Z (2007), "Multicriteria Decision-Making for the Sustainable Built Environment", The University of Reading, Reading, UK. ISBN: 0-7049-1209-0.

Chen, Z, Khumpaisal, S (2008), An Analytic Network Process for Risks Assessment in Sustainable Commercial Real Estate Development, 'Journal of Property Investment and Finance', Special Issue: Sustainable Commercial Real Estate (in progress)

Clarke, J, C and Varma, S (1999), Strategic Risk Management : the New Competitive Edge, 'Journal of Long Range Planning',, volume 32, No. 4, 414 - 424.

Commission for Healthcare Audit and Inspection (2006),"Criteria for assessing core standards in 2006/2007", Commission for Healthcare Audit and Inspection, London.

Crown (2008), Building Regulations Planning Portal, http:// www. planningportal.gov.uk /england /professionals / en /4000000000001.html

Couch, C and Dennemann, A (2000), Urban regeneration and sustainable development in Britain: The example of the Liverpool Ropewalks Partnership, 'Cities', volume 17., No. 2, 137-147

Danter (2007), "A Sample Lodging Analysis in the City of Grove, Ohio", Danter Company, Columbus, OH 43215, USA. <http://www.danter.com/PRODUCT/samplodg.pdf> (30 Dec. 07).

D&B (2007), "Risk Management", Dun & Bradstreet Inc., London, UK. http:// www. Dnb .co.uk /Risk_ Management / Risk_Management.asp> (30 Dec. 07).

Fisher, J D, Geltner, D M and Webb, R B (1994), Value Indices of Real estate: A Comparison of Index Construction Methods,' Journal of Real Estate Finance and Economics', volume 9, No. 2, 137-164.

Frodsham, M. (2007), "Risk Management in UK Property Portfolios: A Survey of Current Practice", Investment Property Forum, London. http :// www .ipf.org.uk/resources/pdf /research /research_reports /Risk _Management _Summary.pdf > (30 Dec. 07).

Flyvbjerg, B., Bruzelius, N and Rothengatter, W. (2003), Megaprojects and risk : An Anatomy of ambition, Cambridge University Press, UK

Healey, P (1990), Urban Regeneration and the Development Industry, 'Regional Studies', volume 25, No. 2, 97-110

He, Z (1995), Risk management for overseas construction projects, 'International Journal of Project Management', volume 13, Issue 4, 231-237.

ioMosaic (2002), "Designing and Effective Risk Matrix: An ioMosaic Corporation Whitepaper", ioMosaic Corporation, Houston, TX 77057, USA. <http://archives1.iomosaic.com/whitepapers/risk-ranking.pdf> (30 Dec. 07).

Jones, C and Watkins, C (1996), Urban Regeneration and Sustainable Markets, 'Urban Studies', volume 33, No.7, 1129-1140

Khalafallah, A, Taha, M and El-Said, M (2005), Estimating Residential Projects Cost Contingencies Using a Belief Network, In: Project Management: Vision for Better Future Conference, 21-22 November 2005, Cairo, Egypt <http://people.cecs.ucf.edu /khalafal/ publications /publications_files /Estimating Contingencies.pdf> (30 Dec. 07).

Kindinger, J P (2002),The Case for Quantitative Project Risk Analysis, In: Tenth Annual Conference on Quality in the Space and Defense Industries, 4-5 March 2002, Florida, USA.<http://www.lanl.gov/orgs/d/d5/ documents /case.pdf> (30 Dec. 07).

Liverpool City Council (2008) "Liverpool City Council Property Tax", Liverpool City Council Website, <http :// www.liverpool.gov.uk /Council_government_and_democracy/Council_tax/index.asp> (19 Mar. 08)

Morledge, R, Smith, A and Kashiwagi, D T (2006), "Building Procurement", Blackwell Publishing, London, UK

Moss,Q Z, Alho, J, and Alexander, K (2007), Performance measurement action research, 'Journal of Facilities Management', volume 5, No. 4, 2007, 290-300.

Mynors, P.(2006). What do we need to consider to deliver a more sustainable city?, In : CATCH Dissemination Event Conference, 28 - 29 June 2005, Liverpool, UK

Rafele, C, Hillson. D, and Grimalai, S (2005), Understanding Project Risk Exposure Using the Two-Dimensional Risk Breakdown Matrix, In: Project Management Institution Global Congress, Edinburgh, Scotland. <http://www.risk-doctor.com/pdf-files/pmi-e-rbmpaper.pdf> (30 Dec. 07).

Saaty, T L (2005), "Theory and applications of the analytic network process", RWS Publications, Pittsburgh, USA.

Titarenko, B P (1997), Robust technology in risk management, 'International Journal of Project Management', volume 15, Issue 1, 11-14.

UNEP (2007) "Buildings and Climate Change - Status, Challenges and Opportunities", United Nations Environment Programme (UNEP), Nairobi, Kenya.

Younes, E, and Kett, R (2007), Hotel investment risk: what are the chances?, 'Journal of Retail Leisure Property', Volume 6, No.1, 69-78.

7 Acknowledgement

This research is funded by Thammasat University, Thailand and supported by School of the Built Environment, Liverpool John Moores University. The authors wish to thank Professor Christopher Couch, professor of urban planning, school of the Built Environment, Liverpool John Moores University and Miss Suwadee Thongsukplang, instructor of urban planning, Faculty of Architecture and Planning, Thammasat University, Thailand for their valuable information, opinions and judgements throughout the research process. Additionally, we wish to thank Mr. David Morley, the Deputy Director of the School of the Built Environment, Liverpool John Moores University, in his effort and his suggestions throughout a completion of this paper.

Enhancing urban sustainability through novel visualisation

Daniel Gilmour, Dr Ruth Falconer, Dr David Blackwood, John Isaacs

University of Abertay, UK

Sustainable decision making in Urban Design is a complex process that requires the interaction of a wide variety of stakeholders. The engagement of a range of stakeholders throughout the decision making process presents challenges including the need to communicate the complex and interdependent facets of sustainability and the need to demonstrate the short and long term implications of alternative courses of action.

This paper presents the results of an initial application of a prototype simulation and visualisation tool (S-City VT) that was developed to enable all stakeholders, regardless of background or experience, to understand, interact with and influence decisions made on the sustainability of urban design. S-City VT takes the unique approach of combining computer game technology with computer modelling to present stakeholders with an interactive virtual development. The paper uses the Dundee Central Waterfront Development Project as a case study to evaluate the potential for the application of the tool and explains how parallel research work on the implementation of a sustainability enhancement framework for the Central Waterfront Development has informed the choice of sustainability indictors and identified the key stakeholders in the decision making processes.

The paper shows how stakeholders can be presented with the outputs from the model using a 3D visualisation of the development and thus enables judgements to be made on the relative sustainability of aspects of the development. The visualisation tool employs a number of different methods of displaying the sustainability results to the stakeholders. These methods can show data in varying levels of complexity, depending on the expertise of the stakeholder, empowering all stakeholders by illustrating possible interactions between indicator values and sustainability and by showing how different stakeholder perceptions of the importance of the indicators can influence the sustainability assessment.

Initial tests on the effectiveness of the different visualisation methods in displaying the model output to communicate the sustainability of the Development are described. The results of the tests and presented and discussed and conclusions are drawn on the further development and application of the tool to model and visualise through time the possible results of decisions made at different stages of the project.

Keywords: assessment tools, comparative urban sustainability, stakeholder participation, urban regeneration, visualisation

1 Introduction

Sustainable development is a vision of progress, which integrates immediate and long term needs, local and global needs, and regards society, environment and economics as inseparable and interdependent. However for many, sustainable development is often seen as a complex issue that is not definable in practical terms. Although a large body of work has been undertaken to conceptualise sustainable development and there is a growing awareness of it, the real challenge is putting a holistic and integrated view of sustainability into practice. An integrated view involves the full consideration of all aspects of sustainability (societal, environmental and economical).

Sustainable decision making in urban design is a complex and non-linear (iterative) process which requires the interaction of wide variety of stakeholders. Effective decision making is dependent on genuine stakeholder contribution during the decision making process, but the current prevailing practice is for decision makers to seek agreement for proposals once the key decisions have been made (Geldof, 2005). Tools to support the decision process are commonplace but are dominated by the perceptions of the "expert" decision makers (e.g. planners, architects, and design engineers) and focus mainly on the technical design and optioneering stages of the process. Sustainable decision support tools have been developed (Ashley et al, 2004) but the applicants have concluded that a major barrier to the development and implementation of tools to support urban design is the complexity of the environment in which decision are made (Bouchart, Blackwood & Jowitt, 2002; Hull & Tricker 2005). In particular, engagement with the general public throughout the decision making process presents challenges in communicating not only the complex and interdependent facets of sustainability in decisions, but also in providing an understanding to stakeholders of the short and long term implications of alternative courses of action.

It is therefore believed that there is a need for new decision support tools that can deal with the complexity of urban design and which go beyond the technical orientation of previous tools (Sahota & Jeffery, 2005) to enable the real inclusion of sustainability in the decision-making processes. The key component of such tools is visualisation to aid interaction between stakeholders. Visualisation has been used to visualise and analyse changes in the urban design arena (Shellito et al. 2004; Semboloni et al 2004) and to model the best options for sustainable transport systems (Kurt, 2004). However, none have been used to communicate to and integrate the various stakeholders to improve sustainable decision-making and stakeholder interaction.

This paper describes a prototype interactive simulation and visualisation platform (SCity-VT) that integrates and communicates complex multidisciplinary information to diverse stakeholder groups, including local authorities and the general public, to enable them to discharge their duties in a way that contributes to the achievement of sustainable development. This platform uses Computer Games technology, for 3D visualization and rendering techniques to generate a realistic urban development, in conjunction with an underlying computational model (Isaacs et al 2008).

The results of the models are shown to the stakeholder in a novel way using a 3D visualisation tool. The stakeholder will be presented with a 3D visualisation of the development that encapsulates the results of the models and thus the relative sustainability of the development. The visualisation tool employs a number of different methods of displaying the sustainability results to the stakeholders. These methods show data in varying levels of complexity, depending on the expertise of the stakeholder, empowering all stakeholders by illustrating possible trade-offs between indicator values and sustainability. Further the tool will model and visualise through time the possible results of decisions made at different stages, affecting the indicator values, during the development using an animated simulation allowing comparisons to be made.

2 Sustainability Inclusion in the Decision Making Process – Dundee Central Waterfront Development Project.

The development work on the tool forms part of a larger research programme, in conjunction with Dundee City Council, to develop a sustainability enhancement framework for the Dundee Central Waterfront project. The elements of this project are shown in Figure 1.

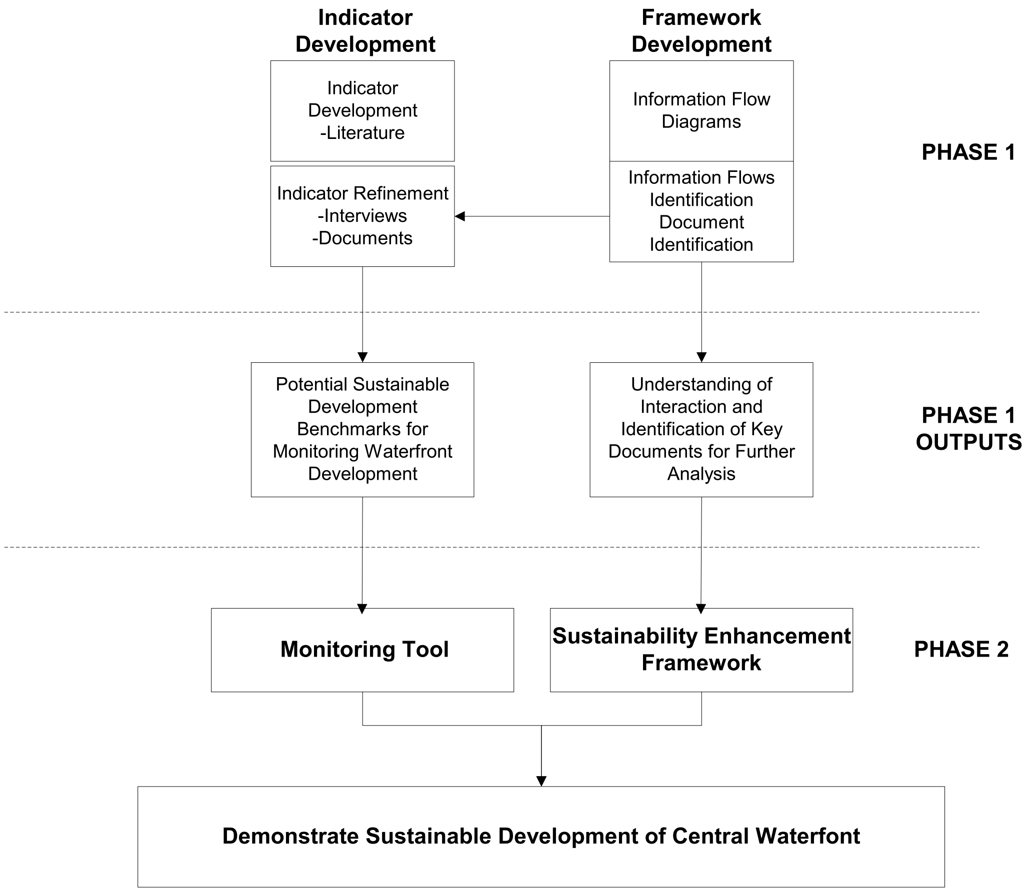


Figure 1 - Dundee Central Waterfront sustainability enhancement study

The enhancement framework will influence decisions taken at various stages of the project's development through the use of indicators that were established to monitor the sustainable development of the Waterfront project. The enhancement framework will combine several activities, each designed to contribute to the overall sustainable development of the waterfront project. Figure 2 outlines how sustainability can be considered at different stages of project life cycle.

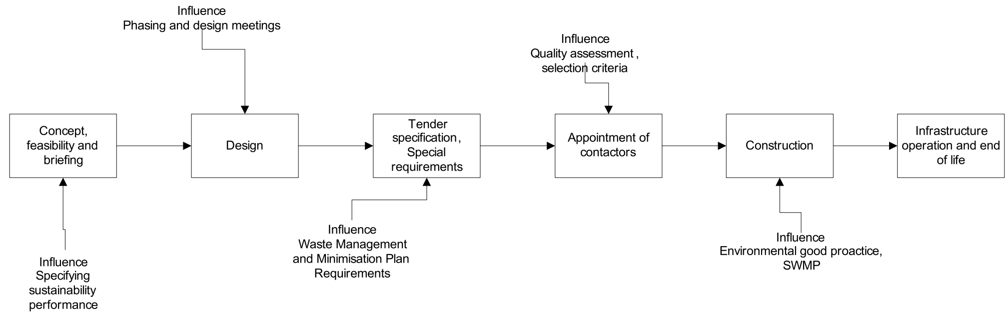


Figure 2. Points of Influence Through the Project Lifecycle

Influencing sustainability at each stage is achieved by embedding sustainable development concepts within the existing decision making and project management procedures and process, e.g. sustainable issues in risk register, special requirement for Site Waste Management Plans in tender documents

Information flow mapping was undertaken at the beginning of the study (Gilmour et al, 2007) to identify key stakeholders, their role in process and the procedures used during decision making. Key Stakeholders include: Dundee City Council Departments, Dundee City Council elected members, Scottish Enterprise, the Scottish Government, Businesses, owners and tenants of existing properties in the waterfront area, the general public, the Scottish Environment Protection Agency and consultants and contractors involved in the Waterfront Development Following this researchers were embedded within the organisation to further identify where sustainability could be influenced in the process and to allow an assessment of the information needs of the stakeholders.

Indicators were developed to provide a benchmark for identifying, reporting and communicating the sustainable development of Dundee Central Waterfront. These indicators help to break down the sustainable development concept to give it a clearer definition and hence make it more comprehensible. Simply put, an indicator is something that helps us understand where we are, which way we are going and how far we are from where we want to be (Simon, 2003). The process of indicator development is an iterative one. The process consists of three main activities, literature review, interviews and document analysis. Each policy document and waterfront specific document that might contain potential sustainability indicators was reviewed and the possible relevant indicators were listed based on the authors' experience of sustainable indicator development (Smith et al., 2002, Butler et al., 2003) and on a range relevant sustainable urban development research papers. The indicators were designed to align as closely as possible with Scottish Government indicators to provide a basis for tangible reporting to the Scottish Government, whilst providing clear and easily understood indicators for internal monitoring at the strategic level.

Where Scottish Government and UK Government indicators did not exist, specific indicators were developed. Unfortunately, most of the papers presented a conceptual understanding of the urban environment and identified key components of sustainability (McAllister 2005) rather than presenting indicators. However, these key components were developed into indicators, which balanced economic, environmental and social aspects of sustainable development. Indicators were only chosen where they allowed a focus on materiality and accessibility (Olsen. L., 2004) - materiality concerns the information stakeholder want and accessibility refers to ability of stakeholders to acquire and understand the information contained in indicators. Indicators also met the following four characteristics (Foxon et al., 2002):

Comprehensiveness: The indicators should cover the three categories of economic, environmental, and social in order to ensure that account is being taken of progress towards sustainable development objectives. The indicators chosen need to have the ability to demonstrate movement towards or away from sustainable development according to these objectives.

- Tractability: Sufficient reliable numerical or qualitative data should be available to enable the estimation of spatial and temporal trends.
- Transparency: The indicators should be chosen in a transparent way so as to help stakeholders to identify why indicators are being considered.
- Practicability: The indicators must be practical in terms of time and resources available for any analysis and assessment.

Each indicator on the list was also reviewed to identify its appropriateness to the Central Waterfront, in relation to its scale, geographical area, unit of measurement, focus and direction. Indicators were then grouped into three categories, Economic, Environmental and Social. A definition for each indicator was then assigned together with draft units.

The benchmark indicators were categorised into two groups based on the geographical scope of the indicator; either Waterfront specific or city/region wide. Waterfront specific indicators data are focussed on the development area, whereas city/region wide indicators data are based on the impact of the Waterfront Development at a city/region scale. An example of the latter type of indicator is Retention of Skills Base, where an attribution of the change due to Central Waterfront will be required. One of three forms of baseline data exists for each indicator:

- An initial baseline value for 2007, e.g. population 142,170,
- A value of 0 as a datum for 2007, e.g. Number of jobs created since 2007,
- N/A (not available) where the indicator is not measurable at this time, e.g. Per capita water consumption of new buildings as the area has not yet been developed.

The indicators will have different responsiveness to changes in the development. For some indicators there will be a change in the indicator only at infrastructure stage or the plot development stage, whereas some indicators will change at some or all of the development stages. For example, an indicator such as Air Quality will be influenced at each stage of the development but Retention of Skills Base, which monitors graduate retention rate, will only be influenced at the plot development stage. The selected indicators are listed in Appendix A.

A random subset of six indicators - two social, two economic and two environmental - were selected for modelling and visualisation in S-City VT to enable the development of the prototype tool.

3 ANP methodology

The ANP methodology uses interactive network structures to give a holistic representation of the overall problem (Saaty 2006). The components of a network may be regarded as elements that interact and influence each with respect to a specific attribute. "That attribute itself must be of a higher order of complexity than the components" (Saaty 2006) and is called a control criterion. Here the control criterion is urban sustainability. To perform ANP the decision maker must identify the network through analysis of the problem to be solved. The decision maker must identify the clusters, elements and their associated relationships and interactions (Bottero et al. 2007). An example network for a sustainable development scenario is shown in fig 3.

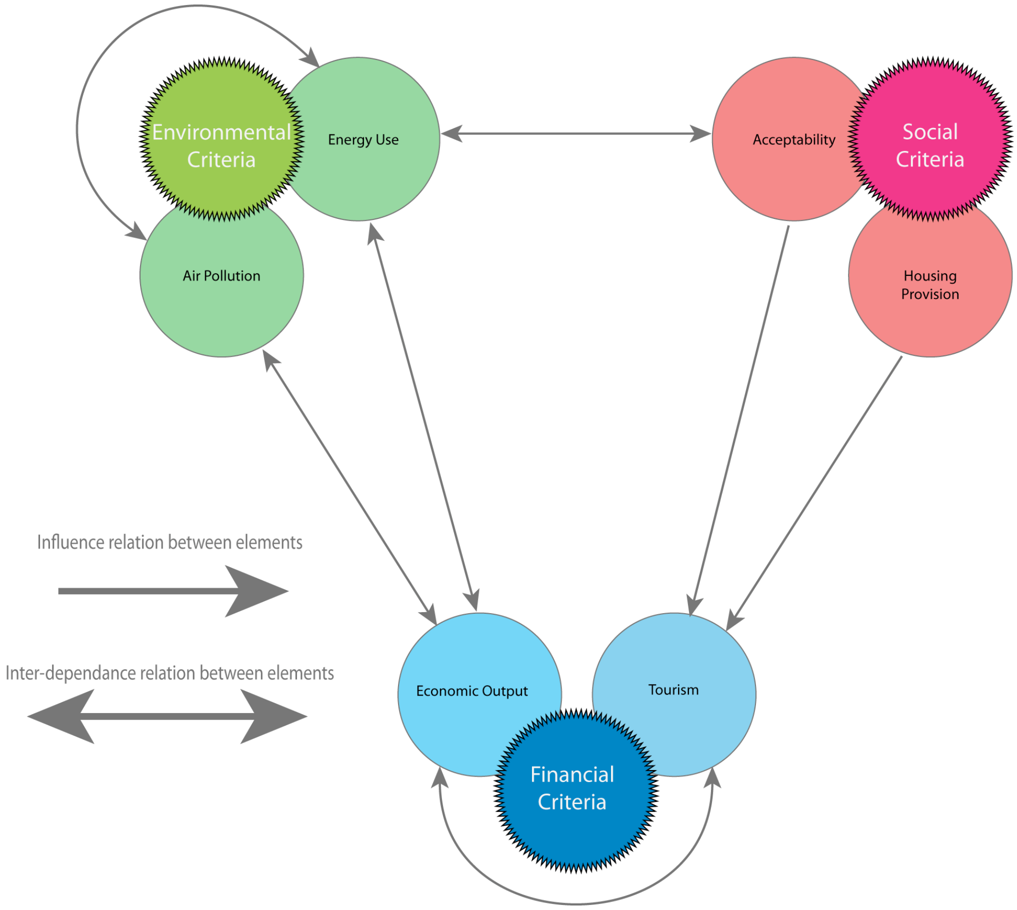


Fig 3. Sustainable development network model.

Once the decision maker has constructed the network a supermatrix describing the indicator interactions is created (Gencer and Gurpinar 2007). This involves making judgements about the relative influence of each indicator on every other indicator, using pair-wise comparison from the fundaments scale (table1).

Table 1. The Fundamental Scale (From Saaty, 1990)

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
3	Moderate Importance	Experience and judgment slightly favour one activity over another
5	Strong Importance	Experience and judgment strongly favour one activity over another
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance is demonstrated in practice
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	For compromise between the values	Sometimes one needs to interpolate a compromise judgement numerically because there is no good word to describe it
Reciprocals of above	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i	A comparison mandated by choosing the smaller element as the unit to estimate the larger one as a multiple of that unit.
Rationals	Ratios arising from the scale	If consistency were to be forced by obtaining n numerical values to span the matrix
1.1-1.9	For tied activities	When elements are close and nearly indistinguishable; moderate is 1.3 and extreme is 1.9

To illustrate the process, pairwise comparisons of the top-level indicator network is given below. Here we can see that this stakeholder rates economic factors 25 times more important than environmental for the social indicator.

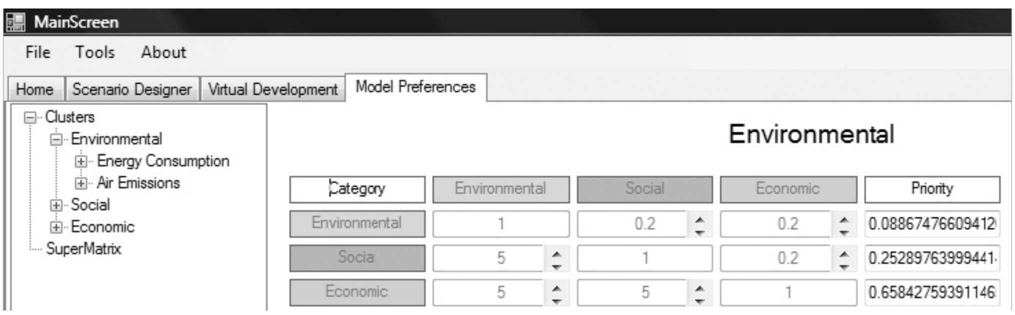


Figure 4. SCity-VT Dialogue for setting ANP parameters i.e. defining the network

When a comparison matrix has been created the elements must be prioritised, this is achieved by calculating the eigenvector, normalised priority weights, of each attribute. (Schniederjans 2004). These eigenvectors are then combined in the supermatrix where every interaction is described in terms of every element it interacts with(Saaty 1999). The supermatrix that is created is via this process is known as the initial or un-weighted supermatrix as it does not yet express the weightings of the overall clusters (Saaty 1999, ;Saaty 2006). A pair-wise comparison matrix must be created to represent the relationship between the clusters, in this case environmental, financial and social. Once this has been completed the calculated eigenvector is applied to the un-weighted supermatrix, this results in a final weighted supermatrix. The eigenvector calculated from the weighted matrix will give the decision maker the prioritised list of elements.

This is a measure of indicator dominance for sustainability for augmentation with the subsystem indicator models and visualisation. For worked examples of the ANP methodology applied to other decision making practices refer to Saaty 2006.

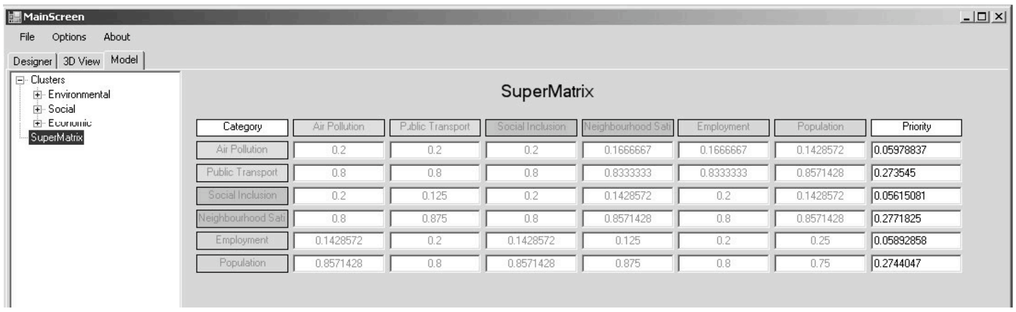


Figure 5. Resulting supermatrix giving priorities/weightings for each indicator value

4 Sub System Models

These are the models that define how the indicators change over time. The indicators currently used by the prototype are housing provision, acceptability, economic output, tourism, energy use and air emissions. As an example we will take the energy use indicator. The current energy use model is an implementation of the standard assessment procedure (SAP) model, which is the governments own standard system for assessing the energy efficiency of buildings. The SAP model allows the stake holder to change a wide variety of variables including glazing type, insulation type, building materials and low energy lighting. The SAP model determines the effect of these variables on the energy use of the building. (Defra, 2008)

The maximum and minimum results for a subsystem are then obtained across all the scenarios being studied. These are used to perform linear maximum-minimum normalization on the results of each subsystem to give a value between 0 and 100.

To determine the sustainability of a specific building, at a given time, in the urban development each of the normalized indicator values, obtained from the sub system models at that time point, are multiplied by the weights/priorities provided by the ANP models. This provides a quantitative measure of sustainability for each building. It is important to note that the tool does not provide an absolute measure of sustainability but provides a mechanism to compare alternative choices i.e. how different proportions of residential to commercial properties effects the relative sustainability.

Figure 6, is a schematic summary that describes the steps involved in the sustainability assessment.

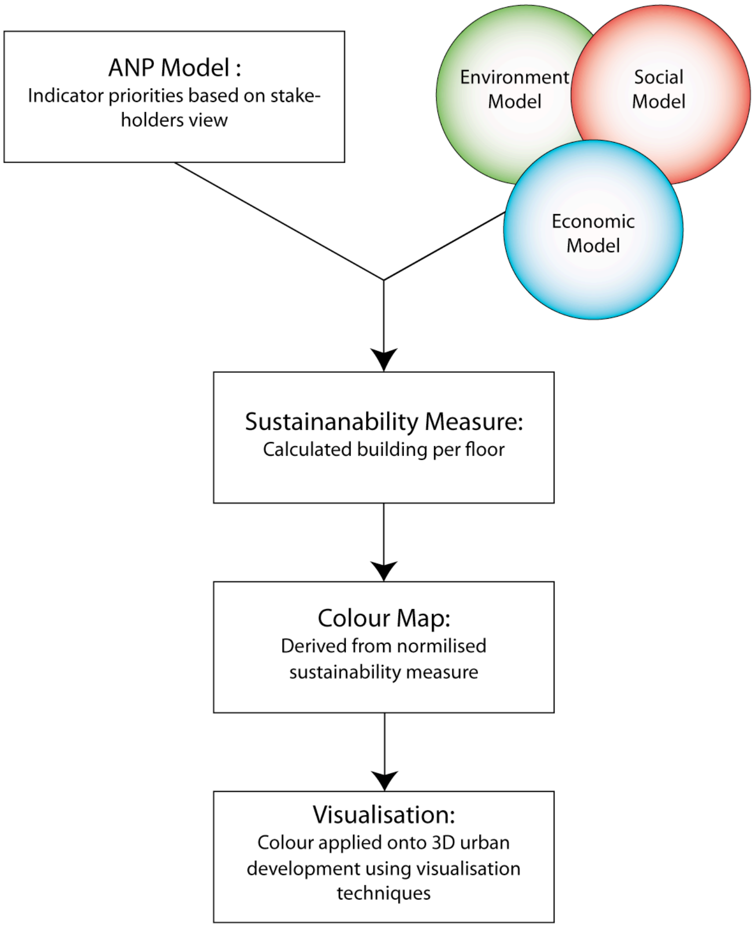


Figure 6. Steps involved in computational and visualisation tool

5 Visualisation Techniques

5.1 Blending

Each element (building, road, water) in the development will now have a sustainability value based on the range of selected indicators. The maps these onto a colour scale using a colour map. The tool is flexible and allows the user to select from numerous colour maps best known for their discriminating abilities (Levkowitz & Herman, 1992). Figure 7 shows the colour scale that is used in the colour maps. Elements that are blue and red will have a high and low sustainability values respectively.

Figure 7. Sustainability Scale as a Colour Map

Blending is simply the combination of all indicators resulting in a single sustainability value. The colour map above can be used to indicate sustainability.

Figure 8 shows that each floor in the building has a different level of sustainability.

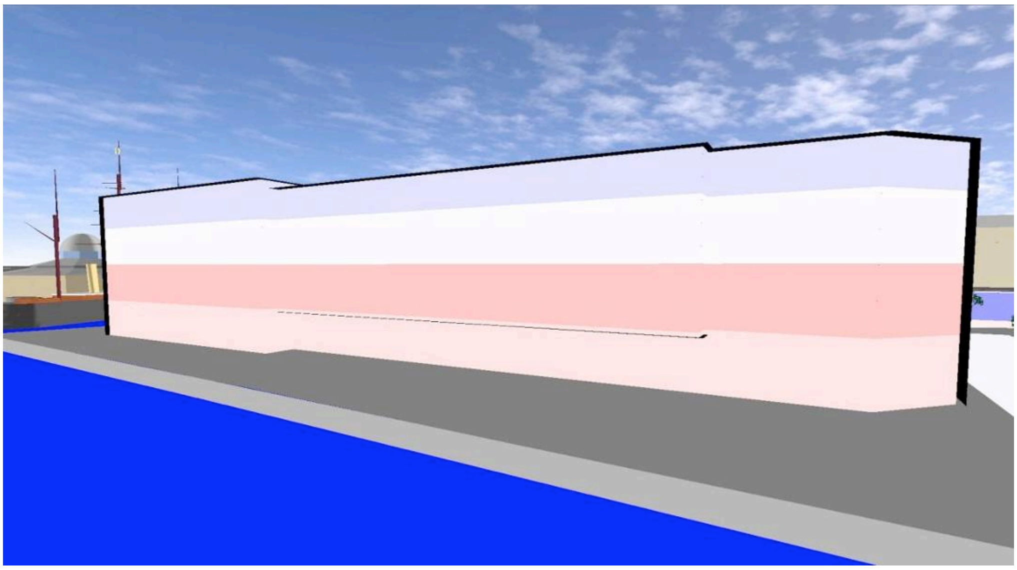


Figure 8. Sustainability Visualisation Using Colour Mapping

5.2 Weaving

Rather than combining all the indicators into a single value it may be possible to preserve some of the underlying information so that we can identify which indicators or clusters are very unsustainable or very sustainable. Here we will use a weaving technique (Hagh-Shenas et al, 2007) that uses a different colour map per indicator (as shown in figures and 9 and 10) to preserve this information.

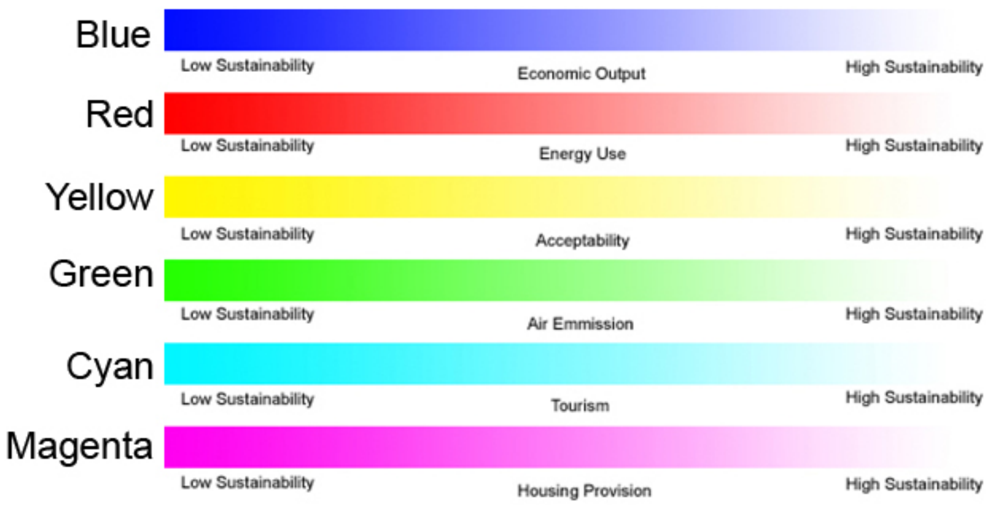


Figure 9. Sustainability Visualisation Using Colour Mapping of Multiple Indicators

The tool allows zooming in on a building so each indicator value could be determined. This will become more complex as the number of indicators being shown increases, to prevent this over complexity the user can turn off indicators they are not interested.

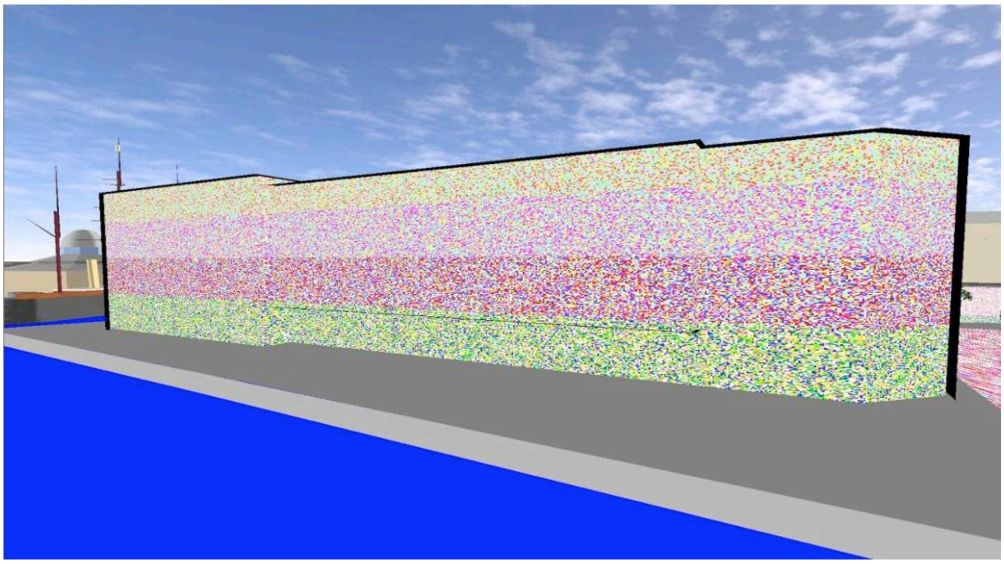


Figure 10. Sustainability Visualisation Using Colour Weaving

5.3 3D Visualisation of the Development

Finally the visualization technique is applied to the 3D development as in Fig 11.

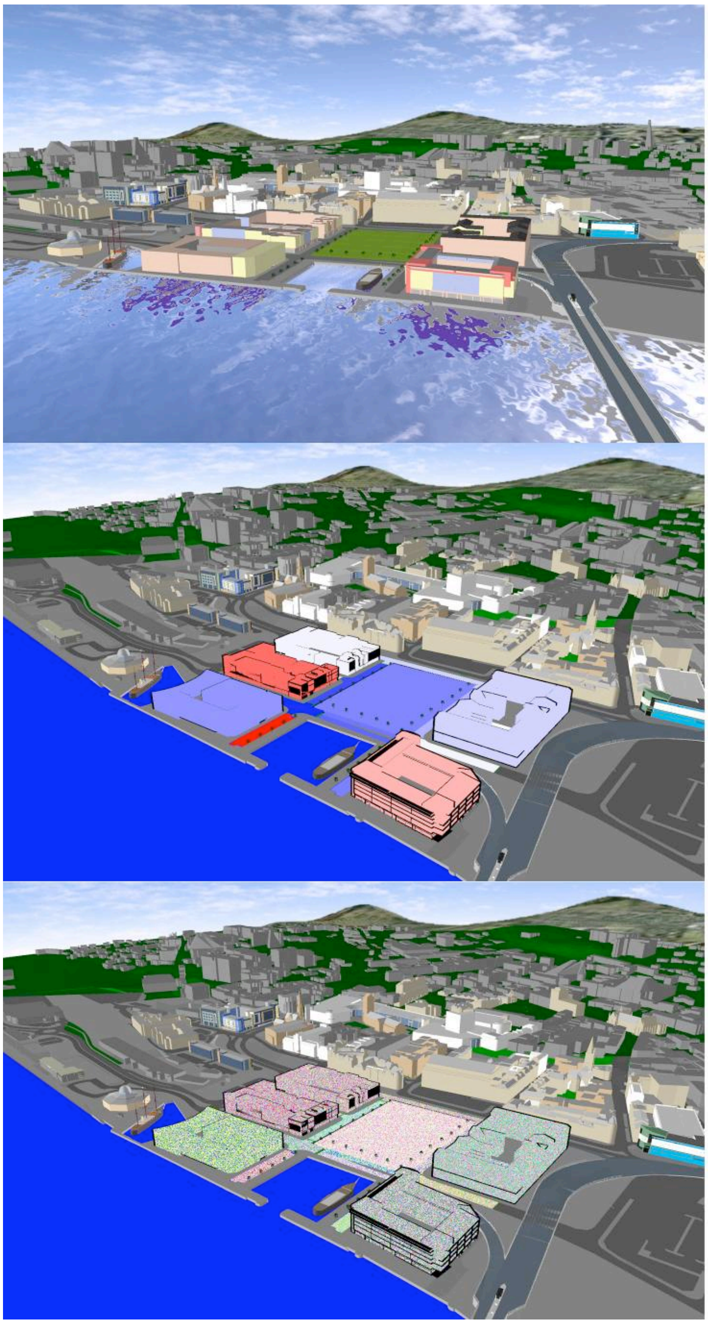


Figure 11. 3D Visualization of development with and without sustainability information

6 Application and Testing of Tool

Testing of S-City VT was undertaken using the Dundee Central Waterfront Development Project as a case study. The parallel research work on the implementation of a sustainability enhancement framework for the Central Waterfront Development has informed the choice of sustainability indictors and identified the key stakeholders in the decision making processes.

The final decision in any decision making process is rarely decided by one person, this is equally true in the urban planning domain, because of this our tests utilised focus groups to simulate the types of consultation and engagement meetings it is envisaged the tool will ultimately be used in. This group methodology will allow a much better insight into the group decision making process than a questionnaire or solo interview and also provide observational data that would be inaccessible without the interactions found in a group (Morgan 1997). The focus groups used will ideally be comprised of between six and ten members of a single stakeholder group; this will allow the greatest range of opinions without reducing the depth and substance of the discussions (Gilbert 2001).

As usability trials are most effective when participants represent real users performing real tasks (Dumas & Redish, 1999), the stakeholder groups will be presented with two scenarios, running simultaneously using a split screen display, as shown in figure 12. The two chosen scenarios will have different potential levels of sustainability known only to the researchers. The discussions and final conclusion, i.e. which scenario was decided to be relatively more sustainable, of the group is recorded and analysed to assess how the group's ability to make judgements on the relative sustainability of the separate scenarios is guided by the tool.

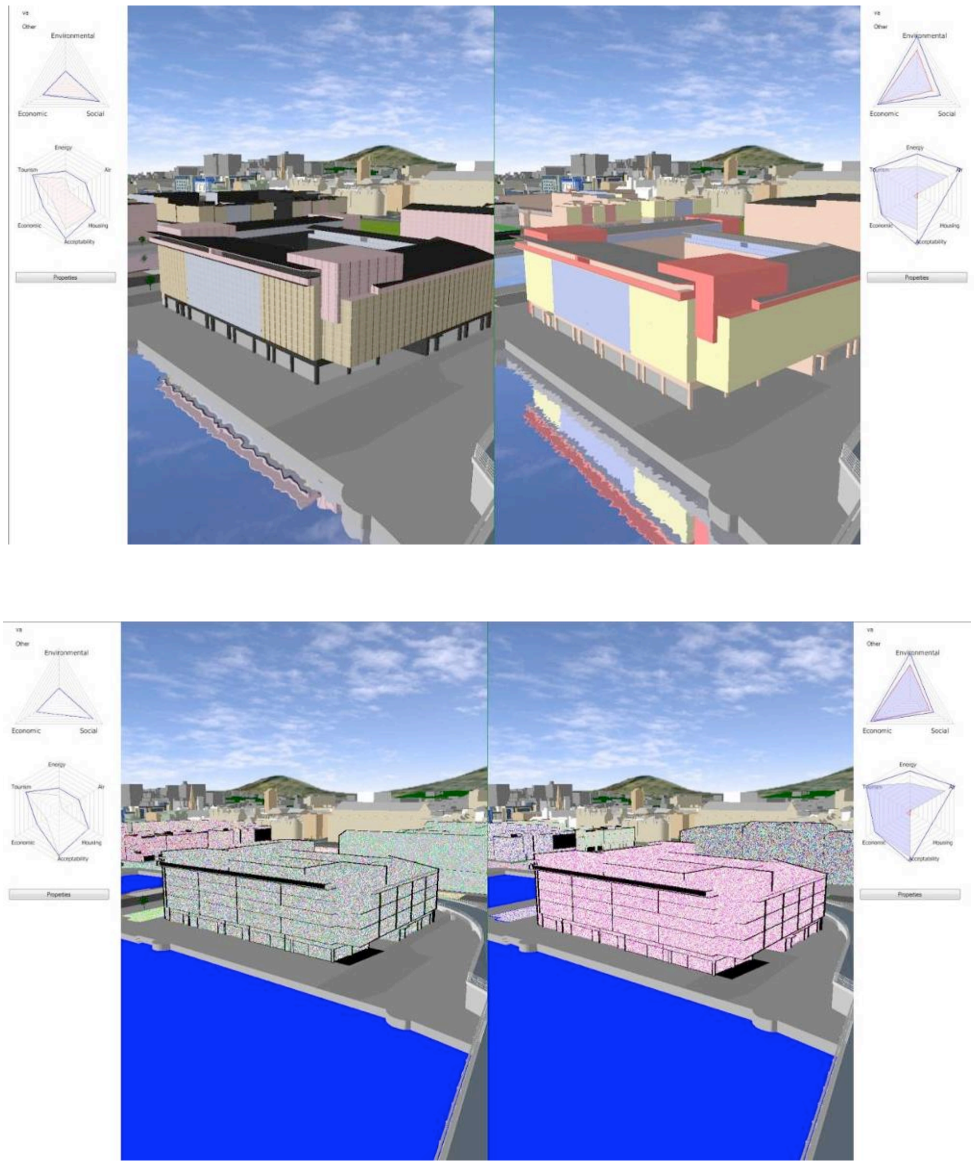


Figure 12: Comparison techniques used for testing.

The testing will not only provide an insight into which of the different visualisation techniques or combination of techniques is preferred by each stake holder group, but also which techniques are most efficient at conveying the complex sustainability information.

The testing methodology was piloted using two stakeholder groups composed of University of Abertay Dundee students on a number of courses and years of study.

Each group was shown two scenarios which displayed a high degree of difference i.e sustainability of 1 and 100. The group was asked to determine using the blend technique, which of the scenarios was the most sustainable. Both groups were able to correctly identify the most sustainable scenario and on analysis of the recordings of each meeting it was also shown that each group's decision was unanimous, with all the individuals also being able to identify the most sustainable scenario.

The groups were then shown two more scenarios, again with the same level of difference of relative sustainability. Using the weave technique the group was asked to determine, not only which of the scenarios was the most sustainable, but also to identify which indicator was having the greatest negative impact. Again both groups were able to identify which scenario was the most sustainable and also were able to clearly identify which indicator was having the biggest negative impact on sustainability.

The third test was designed to determine, for both techniques, the limit at which the stakeholders could no longer determine a difference in sustainability. For each technique, blending, and weaving, the groups were shown a number of scenarios with increasing differences in their sustainability at 10% intervals from 0 to 100%. For both techniques the participants, as a group and individually, were able to correctly identify the most sustainable scenario down to the 10% difference. They were also able to identify using the weave technique which indicators were having the biggest negative impact. Although the participants did say that at first the weave technique was harder to use due to its multivariate nature they all agreed that once accustomed with the technique it was easier.

An interesting observation was that one member of one group did have some difficulty in determining when there was no difference between the scenarios using the blend technique, however the majority of the group did correctly determine that the scenarios were the same. As the pilot test only tested 10% intervals it was not possible to determine if participants could identify differences in the range between 0% and 10%. Further testing will be performed on the range.

The pilot tests show that the majority of participants had no problems extracting sustainability information conveyed via blending and weaving techniques from the tool. More rigorous testing on appropriate stakeholder groups will need to be performed to fully ascertain the tools effectiveness.

7 Conclusions

The sustainability techniques provide a visual sensitivity analysis to show how the relative sustainability changes based on stakeholder's opinions and variation of parameters associated with the indicators such as the proportion of commercial to residential properties. The creation of a 3-D virtual environment allows a stakeholder to feel much more a part of the development because they can actually see it come to life. By projecting the results of the simulation model onto a virtual representation of the actual development, S-City VT allows the user to immediately envisage the consequences of any decisions that they make, and the differences in specific scenarios, over a number of years. The use of visualisation techniques in this way begins to remove sustainability assessment's reliance on the existing expert systems which are largely inaccessible to many of the stakeholder groups, especially the general public. Further after usability testing we know which visualization techniques are effective, in terms of conveying sustainability information to a specific stakeholder group. Since the tool is generic it can be easily applied to different complex urban data, for example the indicators can be changed to model demographic change. The indicators can also be extended to include those which influence water movement to enable the probability of flooding for different scenarios could be assessed.

8 References

Ashley R.M., Blackwood D. J., Butler D. & Jowitt P. (2004). Sustainable Water Services – A Procedural Guide, IWA Publishing, London, ISBN 1843390655

Butler D., Jowitt P., Ashley R., Blackwood D., Davies J., Oltean-Dumbrava C., McIkenney G., Foxon T., Gilmour D., Smith H., Cavill C., Leach M., Pearson P., Gouda H., Samson W., Hendry S., Moir J., Bouchart F. (2003). SWARD:decision support processes for the UK. Management of Environmental Quality, 14, 4, 444- 459.

Bottero, M., Modini, G. and Valle, M. 2007. The use of the Analytic Network Process for the sustainability assessment of an urban transformation project. In: Horner, M., Hardcastle, C., Price, A. and Bebbington, J. eds. International Conference on Whole Life Urban Sustainability and its Assessment, Glasgow, pp.209 - 231.

Bouchart, F J-C., Blackwood, D J. & Jowitt, P W. (2002). Decision Mapping: Understanding decision making processes. Civil Engineering and Environmental Systems, 19 (3), pp187-207, ISSN 1028-6608

Defra, (2008). SAP 2005: The Government's Standard Assessment Procedure for Energy Rating of Dwellings. Version 9.81/9.82, Revision 2, BRE, Watford.Eurostat, (2008) Europa-Eurostat database. http://ec.europa.eu/eurostat

T.J. Foxon, G McIkenny, D Gilmour, et al (2002) Sustainable Criteria for Decision support in the UK water industry. Journal of Environmental Planning and Management, 45 (2), 258-301, 2002

Geldof, (2005). "Integrated water management and complexity". Deventer: Tauw Deventer. ISBN 90-76098-04-2

Gencer, C,Gurpinar, D. (2007). Analytic network process in supplier selection: A case study in an electronic firm. Applied Mathematical Modelling. 31(11): pp.2475-2486.

Gilbert, G.N., (2001). Researching social life, Sage.

Gilmour D, Blackwood D., Banks L., & Wilson, F. (2007). A Sustainability Enhancement Framework for the Dundee Central Waterfront Development. Proc. International Conference on Whole Life Urban Sustainability and its Assessment, Glasgow Caledonian University, June.

Hagh-Shenas, H. et al. (2007). Weaving Versus Blending: a quantitative assessment of the information carrying capacities of two alternative methods for conveying multivariate data with color. IEEE Transactions on Visualization and Computer Graphics. pp.1270-1277

Hull, D. A. & Tricker R. C. (2005). Assessing Barriers to sustainable UK urban transport solutions. Proceedings of the Institution of Civil Engineers, Engineering Sustainability, 158, pp171-180

Isaacs, J. P, Falconer, R, Blackwood, D. (2008) A Unique Approach to Visualising Sustainability in the Built Environment. Proceedings of the International Conference Visualisation, 9-11 July 2008, pp3-10.

Kurt F. (2004). Cybernetics and Systems, Vol. 35. No. 5-6, pp 455-485

Levkowitz, H. & Herman, G. T. (1992). Color scales for image data. IEEE Computer Graphics and Applications. 12(1): pp.72-80.

Morgan, D. L. (1997). "Focus Groups as Qualitative Research". London: Sage Publications, ISBN 0761903437

Olsen. L., (2004). Sustainability reporting: and anchor, not the answer. Engineering Sustainability 157 June 2004 issue ES2 pp. 63-64.

McAllister (2005). Wellbeing Concepts and Challenges. Discussion paper. Sustainable Development research Network, December 2005

Morgan D.L. (1997, 2nd Edition) Focus groups as qualitative research. London: Sage.

Saaty, T. L. (1990). How to Make a Decision: The Analytic Hierarchy Process. European Journal of Operational Research. 48(1): pp.9-26.

Saaty, T. L. ed. (2006). The Analytic Network Process. Melbourne: Idea Group Inc.

Sahota P.S. & Jeffery P. (2005). Decision support tools: moving beyond a technical solution. Proceedings of the Institution of Civil Engineers, Engineering Sustainability, 158, pp127-134

Schniederjans, M. J. 2004. Information Technology Investment : Decision-Making Methodology. Singapore: World Scientific Publishing Company.

Shellito, B. A., Dixon, J., Inge, C. and O'Neal, J. (2004). Tourism Analysis, Vol. 9. No. 3. pp167-178

Semboloni F., Assfalg, J. Armenei, S., Gianassi, R. & Marsoni F. (2004) Computers, Environment and Urban Systems, Volume 28, No. 1. pp 45-64.

Simon 2003. Sustainability indicators. in Neumayer, Eric, Eds. Online Encyclopaedia of Ecological Economics (OEEE). International Society for Ecological Economics.

Smith, H., Gilmour, D., McIlkenny, G., et al. (2002). Decision support processes for the UK water industry – The SWARD Project. The 2002 international sustainable development research conference, University of Manchester , 8-9 April, 2002.

Appendix A: Dundee Central Water Development Sustainability Indicators

Economic

Indicator	**Definition**
Demographics	Population retention
Retention of skills base	Graduate retention rate
Knowledge based employment	Knowledge based employment
Employment	Employment rates
Capacity to stimulate investment	Total inward investment
Tourism	Tourists visiting city centre locations
Regeneration	Increased property value
Job creation	Number of jobs created
Economic output	Economic output

Environmental

Biodiversity	Nesting Swift Population
Green space/public space	Local environmental quality
	Tree population/numbers
Waste	Construction waste recycling
Air	Air emissions continually monitored union street, Seagate
Water	Per capita water use
Noise	Noise level impact
Energy	Energy consumption
Travel	Public transport use
	Bicycle Use

Social

Housing provision	Residential development
Health & Well being	Economic opportunity
Community	Neighbourhood satisfaction
Social Inclusion	Accessibility of waterfront services
Participation and responsibility	Participation in sustainable decision making
Active community participation	Informal and formal volunteering
Acceptability	Acceptability to stakeholders
Confidence	Public perception of confidence
Amenity value	Public perception of amenity of waterfront area

Methods and techniques in use of collective memory for increasing sustainability of urban environments

Mostafa Hosseini Koomleh[1], Fatemeh Sotudeh Alambaz[2]

1 – Naghshe Piravash Consult Engineers, Iran

2 – Tehran Renovation Organization, Iran

Sustainable development is a kind of development that equally provides environmental, economical and social services for citizens in a community in such a way natural, social, economical and man-made systems be in a safe condition. In the previous decades, environmental and economical dimensions were the main focuses of attention. The social dimension of sustainability has become an important component in sustainable discourse since 2000. Collective memory as a socially manifested psychological capacity of an individual, can affect some key theme areas of social sustainability such as social networks, health, identity of community, civic pride, neighborhood perceptions, and community participation. Therefore, conservation and representation of citizens' collective memory will enhance social sustainability and facilitate sustainable development. The aim of this paper is to investigate about how collective memory can be used in architecture, urban design or urban spaces design for increasing urban sustainability. In doing so, an inductive method has been adopted for recognizing main approaches in using collective memories through a comparative study about some experiences and then a deductive method has been adopted to discover some techniques for representing collective memory _as negotiated and selective recollections of a special community_ based on the findings of semiotics. The research findings indicate two main approaches in using collective memory (conservation of memorable objects and representing collective memories). Finally, the study concludes a matrix to model various techniques for representing collective memories, using the findings of semiotics. The study shows the various potential layers and some important facilities of collective memories that can be applied in architecture and urban design projects.

Keywords: collective memory, conservation, representation, semiotics, social sustainability

1 Introduction

Urban settlements are full of inhabitants' memories. Some of these memories are individual but the other ones are social. Collective memory as a social phenomenon plays an important role in urban sustainability and particularly its social dimension. This paper tries to show how collective memory can affect social sustainability and what kinds of methods and techniques can be helpful in use of collective memory for increasing urban sustainability.

In fact, there have been some limited efforts in using collective memory for facilitating urban regeneration projects or representing collective memory in architectural spaces or public places. Nevertheless, it is not all potential layers of collective memory that can be used for increasing urban sustainability.

However, collective memory has been studied by various viewpoints in different sciences (sociology, psychology, anthropology etc.); it is rarely probed that how it can be used in architecture or urban regeneration projects. The aim of this paper is to discover some hidden and potential layers of collective memory that can be used to improve urban sustainability.

In doing so, after a literature review about social sustainability and collective memory, two main approaches in using collective memories has been inductively recognized through a comparative study about some experiences and then a deductive method has been adopted to discover some techniques for representing collective memory, based on the findings of semiotics. The research findings indicate two main approaches in using collective memory (conservation of memorable objects and representing collective memories). Finally, the study concludes a matrix to model various techniques for representing collective memories, using the findings of semiotics.

2 Sustainability and its social dimension

Scheme of sustainable development has been defined at the confluence of three constituent parts. The international Union for Conservation of Nature IUCN has explained sustainable development as a kind of development that equally provides environmental, economical and social services for citizens in a community in such a way natural, social, economical and man-made systems be in a safe condition.

There is general agreement that the different dimensions of Social sustainable Development have not been equally. As figure 1 illustrates, in the 1980's, environmental issues dominated the sustainable development discourse. Also in the late 1990's economic issues became as important as environmental issues. In recent years, social sustainability has also become an important component in sustainable discourse mostly in western governments. As a result, there is limited literature that focuses on social sustainability (Colantonio 2007:4).

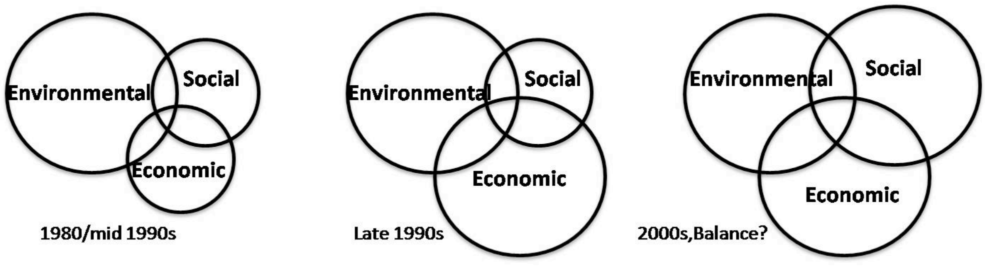


Figure 1: The different dimensions of sustainable development and their relative importance (Colantonio 2007:4)

There has been a wide research programme on social sustainability funded by a grant from European Investment Bank (EIB) containing working paper series since 2006. An exploratory analysis of social sustainability definitions and its assessment, was performed in one of these working papers by Andrea Colantonio. Colantonio mentions some definitions on social sustainability such as Bramely's and then identifies some thematic areas of social sustainability. Bramley et al (2006) distinguishes two all-embracing concepts at the core of the notion of social sustainability. These are "social equity" and the "sustainability of community". The former is linked to the notion of social justice, which urges the fair distribution of resources in society in order to allow fair access to jobs, housing and local services. The second dimension is concerned with the continuing viability and functioning of society as a collective entity. In their analysis on the interactions between social sustainability and urban form, sustainability depends upon on several aspects of community and neighbourhood life, which include (i) interactions in the community/social networks; (ii) community participation; (iii) Pride/sense of place; (iv) community stability; (v) security (crime). Colantonio has expanded the definition of sustainability (2007) and notes that

> *"Social sustainability stems from improvements in thematic areas of the social realm of individuals and societies, ranging from capacity building and skills development to environmental and spatial inequalities"*

In fact, he defined "social sustainability" based on social, socio-Institutional, socio-economic and socio-environmental dimensions. This definition has been explained by thirty-eight key theme areas. According to these two definitions, some key theme areas are indirectly related to collective memory. Collective memory affects social networks, conflicts mitigation, health, identity of the community/civic pride, image transformation and neighbourhood perceptions, well being, partnership and collaboration as key theme areas of social sustainability. Therefore, collective memory has indirect relation with different dimensions of social sustainability. (Colantonio 2007:8)

Describing how collective memory can affect these key theme areas in social sustainability, requires a review on collective memory's definitions and a discussion about the social functions of collective memory.

3 The concept of collective memory

Cities and villages are full of memories that inhabitants keep in their minds. These memories are either individual or social. This study reviews the concept of collective memory as shared memories of inhabitants about their shared past. While memory is understood predominantly as an individual capacity in cognitive and biological sciences, social sciences interpret memory as a collective phenomenon. Collective memory has been used in different studies, ranging from different types of nationalism in history and political science to views of ritualization and commemoration in anthropology and sociology. All of these approaches point out that collective memory is beyond individual memory, but often vary with quite different claims in spelling out this idea (Wilson 2005).

The "collective memory" concept has its historical origins in the "group mind" hypothesis. Based on this hypothesis, groups have minds in such a way that individuals have. The "Group mind" hypothesis can be traced in two distinct traditions: collective psychology and the super-organism traditions.

The super-organism tradition is founded on the studies of communities of organisms. Ecologists, entomologists etc. have used from this tradition to describe the group minds of animals, insects etc. But the collective psychology tradition, began in the final third of the nineteenth century, and includes the work of historians (e.g. Henry Fournial), sociologists (e.g. Gabriel Trade and Emile Durkheim), criminologists (e.g. Scipio Sighele and Pasquale Rossi), and novelists (e.g. Emile Zola) It is motivated by perception of the concept of "the crowd". One can distinguish two strands of thought in this tradition:

1- A negative view of collective psychology (as emotional, unconscious and potentially uncontrollable phenomenon) that is epitomized by Le Bon`s "The Crowd" (1895)
2- A more sanguine view of groups of people and the psychology that was associated with them discussed in sociology and social psychology. The concept of the "group mind" was introduced in this strand (Wilson 2005).

Mourice Halbwachs, French sociologist, first used and introduced the phrase "collective memory", particularly in "The Social Frameworks of Memory" (1992) and in his posthumously published "The Collective Memory" (1980). He had been a student of the philosopher, Henry Bergson and was influenced by the sociologist Emile Durkheim as his work became more sociological in its orientation. He is seen as a part of the collective psychology tradition, particularly of its later, more optimistic strand (Wilson 2005).

Halbwachs's viewpoint builds primarily on a view of collective memory as a socially manifested, individual psychological capacity. His conception of collective memory is based on a contrast between collective and individual memory. Halbwachs also calls individual memory "personal" and "autobiographical" memory and collective memory "social" and "historical" memory (1980:50–52). Autobiographical memory is the memory of things that one has experienced oneself, things that one can remember being present for. Historical memory, by contrast, extends the scope of these memories by including information about the world that goes beyond one's own experience. These are still things that one remembers, and they include facts about what happened on a certain date before one was born, about who has also been to places that you have been to (but not with you)(Wilson 2005 cited from Halbwachs 1980:50-52).

As Halbwachs discusses, the collective memory is always the group memory, always the negotiated and selective recollections of a specific group and therefore collective memory is similar to a myth. From his"presentist" perspective, collective memory is essential to a group's notion of itself and thus must continually be changed to fit historical circumstance (Eyerman 2002:7).

After Halbwachs, different scholars from various academic disciplines have used the concept of collective memory as an inter-disciplinary concept. Citing from Bernhard Giesen, Ron Eyerman, a professor of sociology in Yale University of USA, states:

> "*Collective memory provides both individual and society with a temporal map, unifying a nation or community through time as well as space. Collective memory specifies the temporal parameters of past and future, where we came from and where we are going, and also why we are here now. Within the narrative provided by this collective memory individual identities are shaped*" (ibid: 6).

The concept of collective memory did not exclusively remain as a sociological and psychological term. It gently moved to architecture and urban design literature after 1980's. Aldo Rossi, Italian neo-rationalist architect, is the first who used the concept of "collective memory" in environmental design literature.

Aldo Rossi called city as history in a part of his famous book, “The Architecture of The City”, and then distinguished two historical methods in the study of the city: 1-City as a material artefact built over time and retaining the traces of time. 2-History as the study of the actual formation and structure of urban artefacts. Rossi adopted the second approach in the study of the deepest structure of urban artefacts and thus their form_ or in his words: the architecture of the city. He uses phrase “the soul of the city” for describing the city’s history and introduces it as “the sign on the walls of municipium, the city’s distinctive and definitive character, its memory”. As he discusses:

> *“... One can say that the city itself is the collective memory of its people, and like memory it is associated with objects and places. The city is the locus of the collective memory...” (1982: 128-130)*

In fact, in Rossi’s viewpoint, there is an important linkage between collective memory and cities’ memorable things and places.

As explained before, from Halbwachs’s perspective collective memory is an extra-individual memory and is a psychological capacity that is socially manifested. It is all negotiated and selective recollections of a specific group or nation, and kept in their minds like a myth. Citing from Bernhard Giesen, Ron Eyerman states that c*ollective memory provides both individual and society with a temporal map, unifying a nation or community through time as well as space and shaping individual identit*ies. Herein Kevin Lynch says that the existence of an "Image of Time" is necessary for psychic healthy and mental hygiene (Lynch 1972). In addition, Tuan believes that our encounter with objects and places remained from the past, can create a clear sense of the past and cause forming personal identity and place identity (Golkar 2000: 36 cited from Hull et al. 1994:110) (see Table 1) Collective memory helps in the construction of collective identities and boundaries. It’s the central medium through which meanings and identities are constituted. Thus, it is seen as the essential factor of a meaningful and rich civil society (Misztal 2007:3). Creating place identity can differentiate specific place from the other ones. It also can cause an enhancement in sense of place.

Connectivity with time is one of the factors that lead to sense of affiliation (Pakzad 2008). Therefore, we can claim collective memory affects sense of affiliation through a linkage with objects and places remained from the past, and making a clear sense of common past in the community. In addition, collective memory can enhance spirit of participation and social coherence through making linkages between members of community. So collective memory has an important role in increasing urban sustainability by reinforcing social networks, community participation, partnership and collaboration, increasing psychic health, improving identity of the community and civic pride as key theme areas of social sustainability. (See Table 1)

Scholars View Points	The important consequences of collective memory	Key theme areas of social sustainability	Social functions of collective memory
Lynch: Existence of an "Image of Time" is necessary for psychic healthy and hygiene	Image of Time	Public Image / Community Perceptions	Affiliation
Rossi: City itself is the collective memory of its people, and like memory it's associated with objects and places.	A linkage between Memory and Things/ Place	Public Image / Community Perceptions	Affiliation
Tuan: Our encounter with objects and place remained from the past, can create a clear sense of the past and cause forming personal identity and place identity. .	A Clear Sense of Time Personal & Place Identity	Public Image / Community Perceptions	Affiliation
		Identity of the community/civic pride	Sense of place
Halbwachs: Collective memory is a social memory, it's always the negotiated and selective recollections of a specific group	Agreement and linkage between Community Members	Collaboration and partnership / Public Participation	Social coherence
Giesen: Collective memory provides both individual and society with a temporal map, unifying a nation or community through time as well as space.	Agreement and linkage between Community Members	Collaboration and partnership / Public Participation	Social coherence

Table 1: What is collective memory and how does it work in social life? (Hosseini and Sotoodeh, 2008)

4 Reviewing some experiences in use of collective memory for increasing sustainability

In this point, the main approaches in use of collective memory will be discussed through reviewing different experiences about using collective memory in architecture and urban design projects. Case studies are about war, Holocaust, history and ethnos.

4.1 World War II memorial

The World War II Memorial commemorates the sacrifice and celebrates the victory of the WWII generation. It's located on The National Mall in Washington, DC. This project has represented the collective memory of WWII for American citizens in order to strengthen national identity in a public place. It is located between monumental and historical buildings in Washington as a linkage, which can relate these two in a visual manner (www.nps.gov). It has three projects such as Freedom Wall, Two Arches and 56 Granite Pillars. "Two arches" represnt the Atlantic and Pacific victories. Inside, bronze columns support eagles holding a victory laurel. The WWII victory medal is embedded on the floor. "Freedom Wall" of gold stars commemorates the more than 400,000 Americans who died in the war. "56 Granite Pillars" symbolize the unity of the states, territories and District of Columbia during the war (ibid).

To be surrounded by 56 columns shows the necessity of unity of the states of America. Citizens who walk in these memorial spaces recall painful war memories when they look at Freedom Wall and they commemorate victories when they encounter with the arcades. In this memorial some intangible ideas (the unity of the states, memories of the sacrifices and the victories) are physically embodied in a symbolic way. Figure 2 shows The WWII memorial with pool, granite pillars and one of the arcades.

Figure 2: The WWII memorial (www.nps.gov)

4.2 Korean War veterans memorial

The Korean War Veterans Memorial is located on The National Mall in Washington, DC, in West Potomac Park. It was authorized by Congress on October 28, 1986 and construction began in November 1993. The Memorial is managed by the U.S. National Park Service. The Memorial is in the form of a triangle intersecting a circle. Within the triangle are "19 stainless steel statues" designed by Frank Gaylord, each slightly larger than life size (between 7 feet 3 inches and 7 feet 6 inches), representing a squad on patrol, 15 Army, 2 Marines, 1 Navy Medic, and 1 Air Force Observer, dressed in full gear, dispersed among strips of granite and juniper bushes, representing the rugged terrain of Korea (see Figure 3). To the north of the statues is a path, forming one side of the triangle, and behind, to the south, is a 164 feet long "black granite wall", created by Louis Nelson, with photographic images sandblasted into it depicting soldiers, equipment and people involved in the war, forming the second side. The third side of the triangle, facing towards the Lincoln Memorial, is open (www.worldtourist.us).

The main purpose of creating this memorial was to appreciate the Korean War Veterans. In doing so, some realistic statue of veterans in different modes was used to remind the memories of Korean War. In other words, memories have been physically represented and exposed in this case.

Figure 3: stainless steel statues, The Korean War Veterans Memorial (www.worldtourist.us)

4.3 Vietnam veterans memorial

The Vietnam Veterans Memorial serves as a testament to the sacrifice of American military personnel during one of this nation's least popular wars. The memorial consists of three distinct sections ("The wall of Names", "Three Servicemen Statue" and "the Vietnam Women's Memorial"). The Vietnam Veterans Memorial honours members of the U.S. armed forces who served in the Vietnam War. The main part of the memorial was completed in 1982 and is located in Constitution Gardens on the National Mall, just northeast of the Lincoln Memorial. The Memorial is maintained by the U.S. The memorial grew out of a need to heal the nation's wounds as America struggled to reconcile different moral and political points of view (www.worldtourist.us).

In fact, the memorial was conceived and designed to make no political statement whatsoever about the war. The Memorial is a place where everyone, regardless of opinion, can come together, remember and honour those who served (see figure 4). By doing so, the memorial has paved the way towards reconciliation and healing, a process that continues today. Collective memories of Vietnam War has been represented aiming at reconciliation different political viewpoints. Some statues of both American veterans and Vietnam veterans or women have been created to represent these ideas.

Figure 4: The Vietnam Women's Memorial, the Vietnam Veterans Memorial (www.worldtourist.us)

4.4 Memorial to the murdered Jews of Europe

The Memorial to the Murdered Jews of Europe is a large and unusual Holocaust memorial unveiled in May 2005 central Berlin near the Reichstag and the underground bunker in which Adolf Hitler committed suicide. The memorial consists of about “2,700 concrete slabs” arranged in a grid pattern on a 19,000 square meter site (see Figure 8). Visitors are encouraged to walk between the steles; the memorial can be entered from all sides and offers no prescribed path. An attached underground "place of information" holds the names of all known Jewish Holocaust victims, obtained from the Jerusalem museum Yad Vashem. In June 1997, Peter Eisenman's plan emerged as the winner of the next competition. In June 1998, the Bundestag decided in favor of Eisenman's plan, modified by attaching a museum, which Eisenman would also design. "I want it to be a part of ordinary, daily life," its designer, New York architect Peter Eisenman, told journalists. "People who have walked by say it's very unassuming... I like to think that people will use it for shortcuts, as an everyday experience, not as a holy place" (www.sacred-destinations.com).

This urban space has been designed in such a way that is linked with citizens’ daily life. The extensive space including a lot of concrete cubes, makes a symbolic representation in which sad memories of holocaust can be recalled.

Figure 8: The Memorial to the Murdered Jews of Europe (www.sacred-destinations.com)

4.5 Hakīm Firdawsī Memorial

Hakīm Abul-Qāsim Firdawsī Toosī, more commonly transliterated as Firdawsi, (935–1020) was a highly revered Persian poet. He was the author of the Shāhnāmeh, the national epic of Persian-speaking world as well as the entire Iranian realm. Firdawsi was born in 935, in a village near Tus in Iran. The tomb of Firdawsi was made during the reign of Reza Shah Pahlavi as a memorial by the national heritage association in 1934 (www.wikipedia.org).

The tomb has excellent architecture inspired by the architecture of Achaemenid tombs. It commemorates a patiot man who survived history of ancient Iran. In fact, choosing this style of design shows Iranian people like Firdawsi and respect him as much as Great Cyrus (See Figure 9).

Figure 9: the tomb of Firdawsi, Toos, Iran

4.6 Urban regeneration of Bronzeville

Metropolises such as Chicago and New York have been involved with various problems such as 2 million Homeless people; an average of six murders a day, prostitution, robbery and crime in the later years of the 20th century. Urban Regeneration of Chicago, is one of the projects which began in 1994 in the form of the "Development Guidance Plan for the South of the City Centre: Regeneration of Bronzeville and living in the vicinity of boulevards" document. The main propose of this project was to regenerate this region based on history, collective memory and the racial groups residing there (Piruz 2001:79).

Bronzeville has a long and amazing history, which began in 1779 with the immigration of the first African to South America. The faced slaves of America's internal war went to North America in order to find a better life. After the 1940th, a huge migration to Chicago by African-Americans took place. The adventurous Black people went to Chicago in order to find work and settled in the south of the city centre (www.dig.lib.niu.edu). Bronzeville was as a dream place for African-American's through history. This area was one of the first centres of African-American cultural centres' and was known as rich area. The stagnant economical period in America greatly affected this area. The increase of crime and insecurity caused some efforts to be given for the regeneration of Bronzeville.

The process of this project had been defined in a way to attracting citizens' participation in all of process stages. In fact, they had been expected to show, display their collective memory and historical memories in different ways, maintain, and protect them. This project has been successful and lead to enhance quality of life in Bronzeville, this area attracts many people who come for entertainment, leisure and spending time. Martin Louther King Boulevard has been improved as the main structure of Bronzeville neighbourhood. Local artists made a "great migration statue" as a symbol of the great migration of coloured people from south America to north America. The sculpture represents a black man who has arrived from a hard travel with old clothes and a torn suitcase (see Figure 10).

The Organization of Cultural Centres of Chicago Alliance neighbourhoods suggested a project entitled "Portraits of Chicago", aiming regeneration of the community through history, race and culture. In this project, for appreciating valuable people, their portraits were drawn and painted, with some details of their life story in a permanent exhibition. In addition, local history and Chicago's ethnics were represented in urban spaces by "Mosaic Art" and "Eye on the wall of city" (see Figure 11). The "Bronze Map" (see Figure 12) is one of the other project that shows important places, historical buildings, parks and schools (Piruz 2001:78-84). Some memorable buildings such as the home of journalist and Civil Rights activist Ida B. Wells from 1919-1930 and The Chicago Defender building (a newspaper founded by Robert S. Abbott in 1905 to serve the Bronzeville area) was conserved and refurbished for maintaining some collective memories.

Figure 10, 11, and 12 (left to right): Great migration Statue, Graffiti, Map of Bronzeville, Chicago, (www.dig.lib.niu.edu, www.chicagococal.org, www.blackcoutours.com)

In fact, this urban regeneration project with maintenance and revival of collective memory, has recalled people to take part in different activities and participate in the revitalization process through different small projects like "Mosaic Art", "Eye on the wall of city", "Portraits of Chicago", "Great migration Statue", "Bronze Map" and "23 seats" (see Figure 13) and for the first time has found interesting results. It is important that the link between these projects and inhabitants' collective memory and spending money, time and energy by citizens in doing these projects led to increasing of "Sense of Affiliation" and "Social

Coherence". In addition, these projects led to achieving common goals and increasing participation in Bronzeville.

"Bronze Sculpture" was attended and changed to Bronzeville symbol as a logo for Resident's and Commerce council (see Figure 14). Thus Urban Regeneration Project has been succeed in redefining "Sense of Place", also it cause to attract private sector investment, environment and furniture's maintenance and imageability of place in citizens' mind. Final achievements include some changes in public city image. Bronzeville has been changed from a crowded, untidy, unsafe and horrible neighbourhood to an attractive place for tourists and socially safe neighbourhood for inhabitants. New Bronzeville does not become empty at night unlike the past, but the existence of dramatic groups (see Figure 15), local dance and music groups attract many people and tourists to this area.

5 Recognizing methods and techniques in use of collective memory

After a review on various experiences in use of collective memory in urban regeneration projects or urban spaces design, two approaches are distinctively recognizable. The first is "Maintenance of memorable elements and Emphasis on them" and the second is "Representation of collective memory". When the object(s) related to collective memory exists in reality, the first approach can be used. In other words, the first approach is related to place-based collective memory but the second approach can be used when the collective memory is not referable to a special place. (e.g. immigration of some African-Americans from the South to the North USA). Representational approaches can be helpful in use these kinds of collective memory. In the first approach, techniques in use of collective memory refer to maintenance and, if necessary, refurbishment and repairing the memorable elements and then emphasis on these elements through making them legible and easily visible(by means of lighting, removing visual obstacles, etc) and also making them possible for public using. Nothing is created in the first approach .The efforts only refer to maintenance and emphasis. However, in the second approach, the aim is representation of collective memory through creation of a sign, making collective memory perceptible as a message for citizens. That is why; semiotics can be helpful for adopting suitable techniques in this approach.

What kind of collective memory we encounter with?	Referable to a special place	Not referable to a special place
different approaches in use of collective memory	Conservation	Representation
Some examples	Conservation and renewal of some memorable buildings (The Chicago Defender building and the home of journalist Ida B. Wells) in Brounzeville	Great migration Statue / Portraits of Chicago in Brounzeville

Table 2: The different approaches in use of collective memory

5.1 Semiotics and representation of collective memory

Sign is something that introduces something instead of another one based on a social contract. In other words, a sign is everything that signifies another thing (Ahmadi 1992:32). Signs include the form of words, pictures, sounds, acts … but they are not lonely finished and their signees requires an individual who interpret them (chandler 1999: 10).

Semiotics is a science that studies about signs and their role in social life. Sings that we use in our daily life for communication with environment, signs we perceived and understood, such as traffic signs and signs used in public places... Semiotics shows what the signs made of, and what the rules prevailed among them are (Ahmadi 1992:8).

We usually meet with different layers of signs rather than a single sign. These different layers are perceived by sense of smell, taste, sight, hearing and touch. However, signs can be objectively realized through all these media, nowadays, the sign is often created by hearing and sight medium.

The only application of sense of touch is Braille writing system designed for blind persons and they perceived the signs by touching them (Sojoodi 2003: 175-193). Although the senses of smell and taste have been rarely used, one can consider some important application for them as remarkable signs. For example, the smell of orange flower in the streets of Shiraz is a main part of collective memories in the minds of its citizens. Poets and novelists uses the phrases like "smell of orange flower" in their works. Writing these phrases in the visible points of the most attractive and memorable urban places and planting the same trees (e.g. orange tree) in it can be helpful in creating a sign in different layers (at least two layers, sight layer and smell layer). About the sense of taste, some examples can be given. The taste of "Samanu", an Iranian dessert, which is usually seen in "Haft-Sin" tablecloth, in Nowruz celebration (an Iranian celebration in the beginning of Persian calendar) is a memorable taste. So are the taste of "Qeymeh" (an Iranian food) distributed as a vow in the special religious days (e.g. Ashura, the day of Imam Husein's martyrdom). All these tastes have been become a part of collective memory and can signify some meanings in a multi-layer sign system. Thus, suitable techniques can be made by combining different layers with each other. For examples Hâjji Fîrûz or Hajji Piruz, is the traditional herald of Nowruz. He is a black-faced character clad in bright red clothes and a felt conic hat. While ushering in Nowruz, Hajji Firuz plays a tambourine and sings "Haji Firuz eh, sali ye ruz eh" (It is Haji Firuz time, It happens one day in a year). People of all ages gather around him and his troupe of musicians and listen to them play the drum, and dance (http://en.wikipedia.org/wiki/Hajji_Firuz). There will be a multi-layer signs: visual layer (looking at Hajji Firuz's dancing and his face and clothes) and hearing layer (hearing Hajji Firuz's special music). As another example, playing "Taziyeh" (an Iranian religious street theatre) with distributing "Qeymeh" as a vow in "Ashura" constitute another multi-layer sign: taste layer (tasting "Qeymeh"), smell leyer (spreading the smell of "Qeymeh"), visual layer (looking at "Taziyeh") and hearing layer (hearing players' narrating and sadly singing) These are some techniques for representing Iranian collective memories by means of multi-layer signs.

In addition to categorize signs in terms of different senses that perceive them, another classic taxonomy system presented by Peirce will be helpful in modeling representational techniques. Peirce, American physicist, mathematician, logician (1839-1914) distinguished three kinds of signs: 1.Icons, 2.Indexes and 3.Symbols (Sasani 2003:90 cited from Kristeva 1989:13)

Icon is the sign that there is a formal similarity between its form and meaning (e.g. realistic portraits or statues), index is the sign that there is a causal relationship between its form and meaning (e.g. footprint as a sign for passage, or humidity of soil as a sign for raining, suitcase as a sign for journeying…) and finally symbol is a sign that the relationship between its form and its meaning is based on social contracts (e.g. language, traffic lights, national flag...) (Safav, 2004:16 ; Sojoodi 2003: 32-40)

Peirce's taxonomy system			**Some techniques For representing collective memory**	**Different layers of signs** (Categorization in terms of different senses)
symbol	**index**	**icon**		
Symbolic & memorial statue or painting (conceptual arts)	Using indexes in portraits or statues (suitcase as a sign of immigration)	Realistic portraits & statues/ performing realistic memorable stories	Visual arts (sculpturing & painting)/ dramatic arts (street theatre)	Sight
Playing drams in religious mourning/ … many different symbolic sounds in different cultures	Broadcasting explosion voices by audio devices (a sign for a defend in a war, heroes, martyrs)	Playing a folk music/ singing in street theatre	Playing pieces of music/ singing/ using digital audio devices	Hearing
Spreading the smell of rose flower (a sign for love)	Spreading the smell of smoke (a sign for burning, the Holocaust)	Spreading the smell of a special memorable flower (orange flower)	Flowering and planting	Smell
Candies as a symbol for happiness / "Samanu" a symbol of "Nowruz"	A sweet as a sign for cane in a city whose main product is cane	Serving memorable foods in memorable places	Spreading foods / candies / sweets	Taste
Writing symbolic words by Braille (Hajji Firuz a symbol of Nowruz)	Using indexes in a text written	Writing memorable names under portraits or statues in suitable places	Braille writing system	Touch

However, the examples presented about Pierce's taxonomy in semiotics references, often refer to visual layer, this taxonomy can be used about the other senses. About hearing, Playing drams in Iranian religious mourning or many different symbolic sounds in different cultures is seen as symbols and Playing a folk music by a local musician or singing some poems in "Taziyeh" is two examples of icons in hearing layer and broadcasting explosion voices by audio devices in urban places can be seen as an index for a defend in a war, heroes and martyrs. About smelling, spreading the smell of a special memorable flower (orange flower) by planting its tree or flower in urban places is an icon, or spreading the smell of smoke in an architectural space is an index for burning in a holocaust and spreading the smell of rose flower can be considered as a symbol for love. Serving memorable foods in memorable places is an icon in taste-based signs, serving a sweet in a city whose main product is cane can constitute an index for cane and candies can be a symbol for happiness or "Samanu" is a symbol for Nowruz. Finally writing memorable names by Braille under portraits or statues in suitable places, using indexes in a text written, or writing symbolic words by Braille (Hajji Firuz as a symbol of Nowruz) are examples of icons, indexes and symbols in touch-based signs. Table 3: A matrix for modelling various techniques for representation of collective memories

As a result, two categorization systems (peirce's taxonomy system and categorization in terms of different senses that perceive signs) can constitute a matrix for modelling various potential techniques in various layers to represent collective memories(see table 3). As explained before, we meet with multi-layer signs and some layers of signs are not completely separable. For example, in "Taziyeh" we encounter with sight-based and hearing-based signs. Some signs in "Taziyeh" are icons and some are symbols. Therefore, this matrix is just useful for showing various techniques (in various layers) that can be used for representation of collective memories. Finally, it can be said that signs are cultural entities and cultural context must be considered for creating symbols, icons and indexes. The study shows the various potential layers and some important facilities of collective memories that can be used in architecture and urban design projects.

6 Conclusion

Collective memories as shared memories of inhabitants from their shred pasts can facilitate sustainable development by reinforcing social networks, community participation, partnership and collaboration, increasing psychic health, improving identity of the community and civic pride as key theme areas of social sustainability. Various potential layers of collective memory can be used for increasing sustainability in urban regeneration projects. The paper tried to show and model diverse facilities of collective memory that can be applied by urban management to make development more sustainable .Consequently, two approaches (conservation and representation) and some techniques in different layers were recognized. Conservation of memorable places and representation of some collective memories can help people to remind their shared memories. Thus, it is important to make physical representations inclusively perceptible for people who meet with them.

7 References

Ahmadi, Babak (1992) "From Pictorial Signs to the Text", Tehran: Nashr-e Markaz

Colantonio, Andrea (2007) " Social Sustainability: An Exploratory Analysis of its Definition, Assessment Methods, Metrics and Tools" Headington: Oxford OX3 OBP, in http://www.brookes.ac.uk/schools/be/oisd/sustainable_communities/index.html, 1-8

Eyerman, Ron (2002) "cultural trauma: slavery and the formation of African American Identity", Cambridge university press

Golkar, Kourosh (1999) "An Investigation into the Definition of Urban Design", Tehran: the centre for Iranian urbanization and architecture studies

Halbwacks, Maurice (1980[1950]) "The collective memory", translated by Francis JD JV, Vid YP, reprinted by Harper colophon

Hall, I, R.B. et al (1994) Place Identity: Symbols of self in the urban fabric, "landscape and urban planning", 28 (2/3): 109-120

Hosseini, Mostafa; Sotoodeh, Fatemeh (2008) "the role of collective memory in urban regeneration", unpublished paper

Kristeva, J. (1989)"Language the Unknown: an Initiation into Linguistics, translated by: A.M. Menke, New-York: Columbia University

Lynch, Kevin (1972) "What time is this place?" Cambridge, mass: the MIT press

Misztal, Barbara A. (2007) "Collective Memory in a Global Age: Learning How and What to Remember" in Collective Memory and Collective Knowledge in a Global Age: an Interdisciplinary workshop, London

Pakzad, Jahanshah (2008) "Environmental psychology" in "postgraduate urban design course", the faculty of Architecture and Urban Planning, Shahid Beheshti University, Tehran, Iran

Piruz, Poria (2002) Revitalization of Metropolises' Centre as A Cultural Project (Case study: Chicago),"Quarterly Journal of Urban Management & Planning", Volume 2, No.8, 78-84

Rapoport, Amos (1982) "The Meaning of the Built Environment", Beverly Hills: Sage

Rossi, Aldo (1982) "The Architecture of the city", Cambridge, mass: the MIT press

Safavi, Kourosh (2004) "Forming the Sign" in: Farzan Sojoodi(Eds) Procs, First Seminar on Art Semiotics, Volume 1, 13-25

Sojoodi, Farzan (2003) "Applicable Semiotics", Tehran: Nashr-e Qesseh

Sojoodi, Farzan (2004) (Eds) Procs, First Seminar on Art Semiotics, Volume 1, Tehran: The Iranian Academy of the Arts

Sasani, Farhad (2003), Multi-dimensional Semiotics an arts, "Quarterly of Khial", No.6, Tehran: The Iranian Academy of The Arts, 90-101

UCN (2006) "The Future of Sustainability: Re-thinking Environment and Development in the Twenty-first Century". Report of the IUCN Renowned Thinkers Meeting, 29-31 January, 2006 http://cmsdata.iucn.org/downloads/iucn_future_of_sustanability.pdf

Wilson, Robert (2005) "collective memory, group minds and the extended mind thesis", in http://www.arts.ualberta.ca/~raw/collectmem.pdf

http://www.dig.lib.niu.edu/gildedage/culturaltourism/laurasummers/places,visited at: September 2008

http://www.chicagococal.org/COCAL6-photos/mural3-01.jpg, visited at: September 2008

http://www.blackcoutours.com/images/Bronzeville_homepage.jpg, visited at: September 2008

http://www.ms.wikipedia.org/wiki/Hakim-Abul-Qasim-Firdausi-Tusi, visited at: December 2008

http://www.sacred-destinations.com/germany/berlin-memorial-to-the-murdered-jews-of-europe, visited at: December 2008

http://www.worldtourist.us/nationalmall/memorial.html, visited at: December 2008

http://www.nps.gov/wwii/planyourvisit/directions.htm, visited at: December 2008

GIS analyses of low density urban areas — how much surface per floor space?

Clemens Deilmann, Joerg Hennersdorf

Leibniz Institute of Ecological and Regional Development, Germany

The resource consumption for urban infrastructure should not be omitted when looking for sustainable urban development. The expenditure for infrastructure is a clear function of urban density. But even within specific types of urban residential areas – which are linked to characteristic density - the margin of variants can be very large. Beside this fact it is true for most of the existing stock (residential areas) that the material resource consumption for maintenance of technical infrastructure over a 100 year life span is higher than for buildings.

The research project presented used GIS tools to analyse urban settlements based on the urban structural type (UST) approach. An UST is a built up area of homogeneous character (open space/buildings) along which the urban area can be differentiated and most physical aspects can be described (material flow, land take, ecological indicators).

More than 500 blocks (polygons) of residential area within a city were analysed.

Three issues will be presented

- the relation between infrastructure and floor space along different urban densities
- a comparison between different Urban Structural Types in terms of land take and material flow
- detailed analyses of low density areas with regard to infrastructure efforts.

Keywords: MFA, infrastructure, urban density, urban structural type

1 Introduction

A practical and appropriate way to describe specific properties of the urban fabric of a city is by use of typologies for buildings and urban areas with characteristic layout of buildings and open spaces. Typologies in spatial science are the essential way to reduce complexity, and recognise, discover and analyse spatial development phenomena. Typology approaches are used to describe buildings, infrastructure and the urban structure. Urban structure types (UST) are basic spatial units with physiognomic homogenous characteristics, designated by characteristic formations of buildings and open space such as development patterns like neighbourhoods dominated by single-detached family homes or linear developments of the 1950s. They describe land use areas with similar environmental and infrastructure conditions and similar use (functions) and indicate the time of origin. They provide a picture of the morphological situation of the urban area (Duhme and Pauleit, 1999) while at the same time representing core characteristics for structural analyses synthesised from representative objects and databases. Basic sets of pre-defined USTs exist in literature, but the USTs used for analyses will usually have to be adapted according to the specific the objectives of the investigation for example if environmental issues of green areas, or building material issues need to be covered.

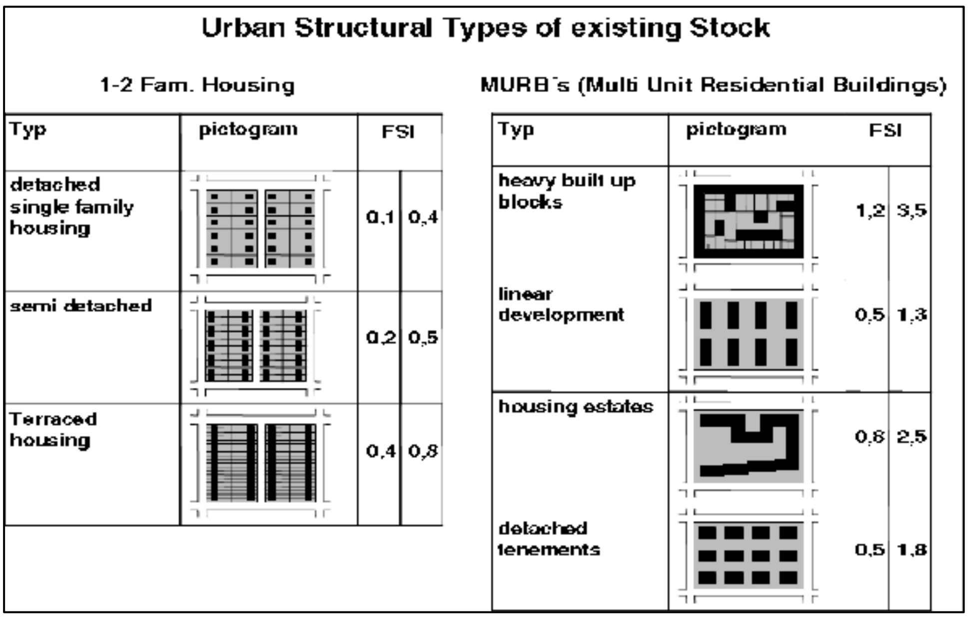


Figure 2: An example of Urban Structural Types for residential buildings

Each UST is characterised by typical urban density values and by that USTs as spatial units interlink buildings and related infrastructure. Small-scale parameters for infrastructure equipment, e.g. length and profile of pipes, as well as population density parameters are both based on empirical and statistical data that can be attributed to USTs. This is an important and necessary step in order to illustrate the effects of urban density on infrastructure elements (Schiller 2007). The resulting “city map” allows calculation of resource intensity and expenditure at city level, for districts, neighbourhoods or micro-scale (1-5 hectares).

Starting point of the investigation was a digital block-map of the city of Dresden. More than 3650 polygons of residential area – about 2-5 acre each - within the municipality needed to be attributed along seven defined UST. Theses polygons assemble 400 Statistic blocks/ neighbourhoods of Dresden. Beside the digital block-map aerial photography and cadastral maps 1:10 000 were used to select the areas. The floor space density for these polygons was then calculated by division of gross floor space - given by statistic of these blocks - and the net residential area. The findings were compared with empirical on-site investigation of areas identified as representative for the specific Urban Structural Types. These representative areas were investigated in detail and planimetered on base of cadastral maps 1:1000. Characteristic values for these areas were calculated and compared with the GIS-calculation-results.

The empirical recognition of urban types can be done visually by hand on the basis of maps and aerial photography or with the support of GIS tools. The state of the art depends on the geo-data availability for the cities. Some cities do have a digital building mask of the entire administrative area, and the vector-data allows almost one to one calculations for the built up area. The polygons of buildings and land area are attributed with certain information such as age, size, number of dwellings, population density etc., which simplifies the recognition of building types and urban structures.

Another option - if cities don't provide this information - is automatic settlement recognition and characterisation on the basis of remote sensing data (Michel et. al 2006) or through urban structural type recognition and evaluation based on digitalised topographical maps (Meinel, 2006).

2 Specific density values for defined UST

The comparison proved on one hand, that the **average value** of a specific UST calculated by GIS and the empiric value of the representative did mach quite well (+/-15%), but on the other hand the **deviation from the average** of a UST could reach factor 2-10. Deviations in medium to high density areas were up to a maximum of factor 4. Densities found in single home residential areas were up to factor 10 and densities could exceed levels of heavy build up blocks with 1.7 FSI (Tab 1).

Some of these deviations were easy to explain, as polygons didn't in all cases contain exceptionally just one type of building associated with the UST. For example some multifamily residential buildings (MURB'S) could easily be part of a polygon which was identified by aerial photography and cadastral map as single family residential area.

The investigation focused on low-density areas (single family homes), because of this high deviation and the fact, that infrastructure material- and land-take per square meter floor area grows exponentially below densities of FSI 0.5 (gross floor space in m² per net residential land in m² = FSI floor space index), (Schiller 2002; Gassner et al. 1986).

Tab 1 Floor space index of characteristic urban residential areas (UST in Germany) by on-site and GIS-analyses

Abbre-viation	UST-Title	On-site empire (Representative)	GIS-empire average	Value range without outliers
SFH-1	Free standing single family homes	0.15	0.26	0.10 - 0.94
SFH-2	Semidetached or Terraced	0.37	0.38	0.20 - 0.91
MURB-1	Heavy build up blocks	1.19	0.91	0.51 – 1.65
MURB-2/3	Linear Development (20ies- 50ies)	0.85	0.86	0.48 – 1.50
MURB-4	Prefabricated housing estates	1.19	1.09	0.52 – 2.00
MURB-5	Open Block detached tenements	0.72	0.77	0.50 – 1.43
MURB-6	Open blocks, Villas	0.39	0.53	0.10 – 0.94

3 Low density area - GIS-analyses

The further investigation concentrated on how to detect the uncertainties of GIS-analyses. A second indicator to differentiate areas was introduced for better understanding of the density related issue: the surface area of roads and sidewalks per gross floor space (RSI = Road space index). The indicator is in a similar way as the FSI a direct function of urban physical density (Buchert, M. et al. 2004). Out of the 3650 polygons about 260 were of single family home areas, which could be need for the investigation focus. These single family home areas were analysed in a graphic synthesis of these two indicators (Fig.: 1).

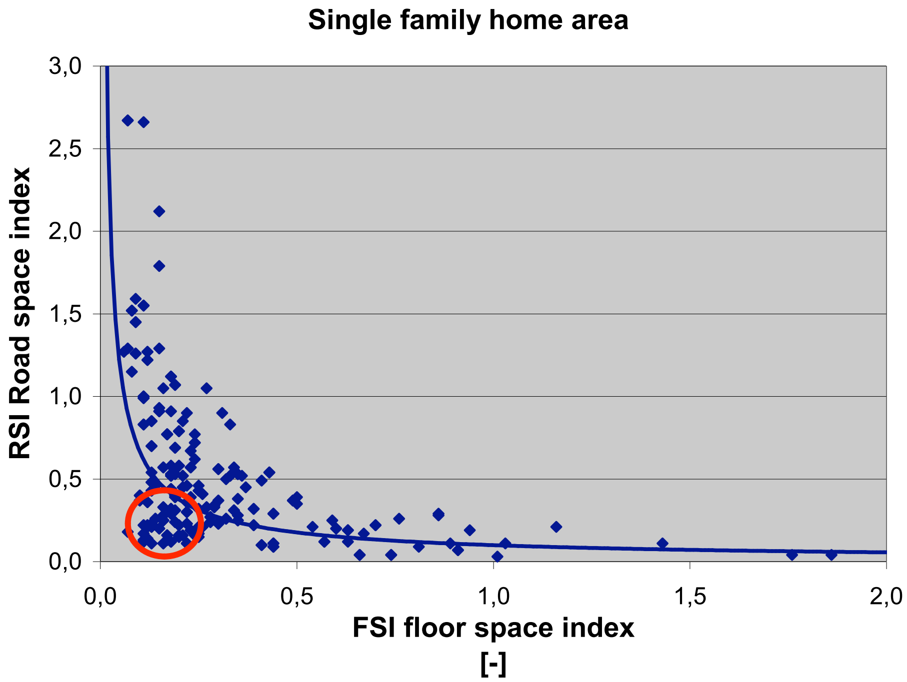


Fig. 1 Relation Road-Space-Index to Floor Space Index

The correlation between RSI and FSI is illustrated well by the diagram. Each dot stands for a polygon of single family home area. But the illustration brings some queerness to the attention. There are densities higher 1.0 and areas with very low density but at the same time with very low RSI smaller 0.3. This could lead to the presumption, that these areas are of high efficiency in terms of required road-surface per house or floor space. A closer look at these areas presented the same specific peculiarities for all of them. They were housing areas situated in merely rural areas in the outskirts of the municipality. The road-surface allocated to them was very few, because the GIS automated algorithm does allocate amounts of public roads surface relational to the spatial extension of adjacent polygons. In this case large polygons of agricultural area took the burden of road surface, while the comparatively small housing areas took a far too small proportion. At the same time it could be observed, that the polygons drawn around housing areas in the outskirts were often too narrow and therefore too small in area. This problem was solved by the decision to allocate roads and sidewalks predominantly to residential areas (transit roads from one settlement to the next were anyway excluded from the investigation). The query types queued into the exponential curve. Having done this a second problem occurred (Fig. 2).

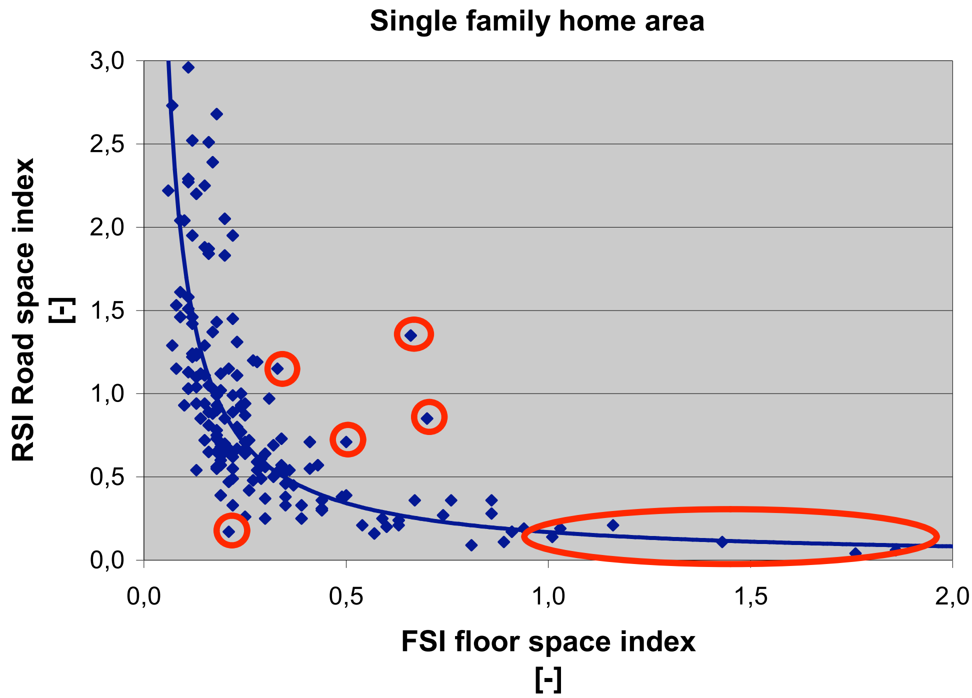


Fig. 2 Relation: Road-Space-Index to Floor-Space-index – rural area corrected

Checking some strange outliers it was found, that some of digital maps used as base for the survey - the Dresden digital block-map - did not comply with the statistical blocks, or by attributation “industrial area” or “agricultural area”, some polygons “disappeared” from the housing area, but statistics still mentioned housing floor space. Secondly, as mentioned above, the attributation to one of the seven UST was not always that unequivocal. Single family homes, large villa (single family) and open MURB were not that easy to distinguish by aerial photography and cadastral maps. By looking at these outliers in a hot spot analyses, some of the misinterpretations could be corrected (Fig. 3).

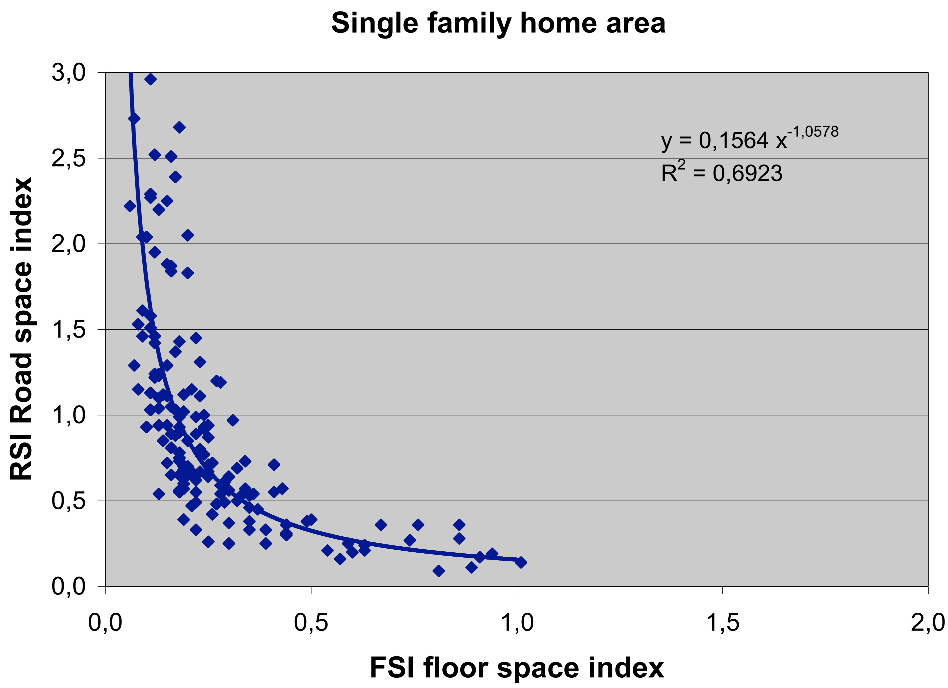


Fig. 3 Relation: Road-Space-Index to Floor-Space-Index – without outliers

The result of the analyses of single family home areas shows a scattered band, but a good regression coefficient of 0.7 with a clear exponential function between FSI and RSI. Last not Least, the GIS-analyses detected more than 36 % of analysed polygons to have more **than one square meter of road-surface per square meter of floor space.**

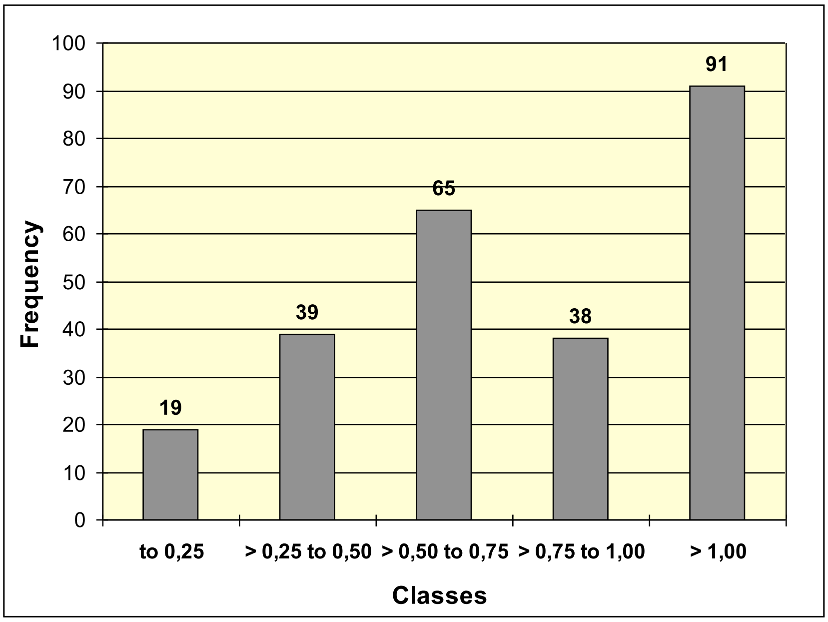


Fig. 4 Road-space-Index – Classes (m²R/m²Fl), Frequency (No. of SFH polygons)

One can link these findings to the sustainable development discussion. What is the specific resource consumption, the land take, the long term maintenance efforts and in result the costs for different urban settlement areas? Who will pay for these structural effects?

What does an urban structure situation of 1 m² road per m² floor space mean in resource terms? Bringing in research findings from Material Flow Analyses one can illustrate, that in this case 1.5-2.0 tons of buildings material will be embodied in roads and sidewalks and 2.5-3.5 tons materials in residential building. The investigation shows, that even material proportions of 1 ton to 1 ton can be found. The material and cost efficiency of urban settlements varies a lot. It is very much determined by urban density and type of access-grid. (Siedentop et al. 2006), inefficiencies.

4 Conclusions

The physical characteristic of urban areas can be analysed by patterns of urban residential areas (UST approach). The analyses bring up a whole sequence of characteristic features for the defined UST (German case).

Looking at infrastructure and urban density characteristics, the allocation of road surfaces to residential areas in outskirts of cities need to be well defined.
The GIS-analyses (digital aerial Photography, digital cadastral maps) interlinked with statistical data shows highly congruency to on-site empirical analyses results. This is particular true when looking at the average values.

An automated GIS-analyses will always need handmade correction, as some of the values suggest by great discrepancy wrong data entries. The corrections can by limited to some outliers and by that great time savings are possible on the way to achieve municipal wide area analyses.

GIS-analyses can deliver fast and extensive empirical data. The empirical data on physical urban form, on density characteristics, infrastructure efforts, Material flow, land take and costs of settlement structures allows plentiful monitoring options to support urban planning. The efficiency of settlement structure is of high importance. GIS-analyses using the UST-approach can guide the way for action towards a settlement structure with better environment and lower cost.

5 References

[1] BUCHERT, M. ET AL. (2004): *Nachhaltiges Bauen und Wohnen in Deutschland*. UBA-Texte 01/04. Berlin.

[2] GASSNER, E., HECKENBÜCKER, B., THÜNKER, H. (1986): Entwicklung des Erschließungsaufwandes nach Flächeninanspruchnahme, Bau- und Bodenkosten: Eine Untersuchung für Verhältnisse im Verdichtungsraum und im ländlichen Siedlungsraum. Forschungsbericht. Informationszentrum Raum und Bau, Fraunhofer-Gesellschaft, T 1845. Stuttgart.

[3] SCHILLER, G. (2002): *No Sustainable Building without Sustainable Infrastructure*. In: Dyrstad Pettersen, T.: Sustainable Building 2002 - 3rd International Conference on Sustainable Building, 23 - 25 September 2002, Oslo, Norway. Summaries. Oslo: EcoBuild, 2002, S.25.

[4] SIEDENTOP, S., SCHILLER, G., GUTSCHE, J-.M., KOZIOL, M., WALTHER, J. (2006): *Siedlungsentwicklung und Infrastrukturfolgekosten – Bilanzierung und Strategieentwicklung.* Forschungsvorhaben im Auftrag des Bundesamtes für Bauwesen und Raumordnung sowie des Bundesministeriums für Verkehr, Bau- und Wohnungswesen. Abschlussbericht (BBR-Online-Publikation, Mai 2006).

The urban green volume — how to calculate

Clemens Deilmann, Guenter Arlt, Iris Lehmann

Leibniz Institute of Ecological and Regional Development, Germany

The urban environmental quality depends very much on the ecological performance of urban green. Key factor for the microclimatic situation of cities is the green 'volume'. The volume can be differentiated into three basic layers of green which are of importance to urban planning. For example low vegetation (lawns) does have good assimilation values. High vegetation (trees) is favorable to improving air-temperature and moisture. Parks, where all layers of vegetation exist, do have high bioclimatic impact for the overall city balance. The Leibniz Institute of Ecological and Regional Development (IOER) analyzed empirically 116 cities in Germany to discover relations between urban green and the different land use categories. This was done with help of GIS-tools (feature recognition). Important factors for the green volume situation of cities as a whole are sealed surfaces, forest, water and minimizing areas. The results are cause-effect relations and models for urban green. These models can be helpful to develop planning strategies and management tools.

It was possible to identify 5 characteristic clusters of cities within the 116 cases. The ecological quality and quantity of green volume and connectivity could be linked to the 5 clusters with average values and indicators. The clusters take into account the land use structure, the land use density, the green volume and its spatial distribution. The information does support decisions in urban planning especially when it comes to deciding on how and where to use brown field areas.

Keywords: cluster-analyses, environmental quality, green volume

1 Context and Goal of the Study

Urban greenery is a quality factor in the ecology of cities. In particular, the supply of urban green spaces strongly influences climatic conditions and air hygiene. The type, level, and spatial distribution of urban vegetation are determined by the uses to which land is put. Land-use structures interact with ecological production, living-environment, and regulatory functions. Knowledge about causes and effects is required if land-use patterns are to shape ecological quality in the city. Urban ecological quality is part of environmental quality. It is a measure of the extent to which the status of the urban environment deviates from the environmental protection and nature conservation targets set by society.

Green space in cities exhibits various spatial patterns. Its positive ecological impact depends largely on how much of the urban territory it occupies, its spatial distribution, and the biomass of total vegetation (vegetation or "green" volume). The study investigated the proportion of green space and vegetation volume, which, together with ground sealing, interconnectivity, and ecological quality levels, providing a basis for ensuring the differentiated internal development of urban ecological quality. Within cities, the findings permit conclusions to be drawn about deficiencies in the supply of green spaces at the district or neighbourhood level.

2 Urban Green Space as Indicator of Ecosystem services

Ecosystem services refer to the degree to which functions are performed in the context of land use (Arlt et al. 2001).

The supply of urban vegetation influences ecosystem services. It is thus also an indicator of certain environmental situations.

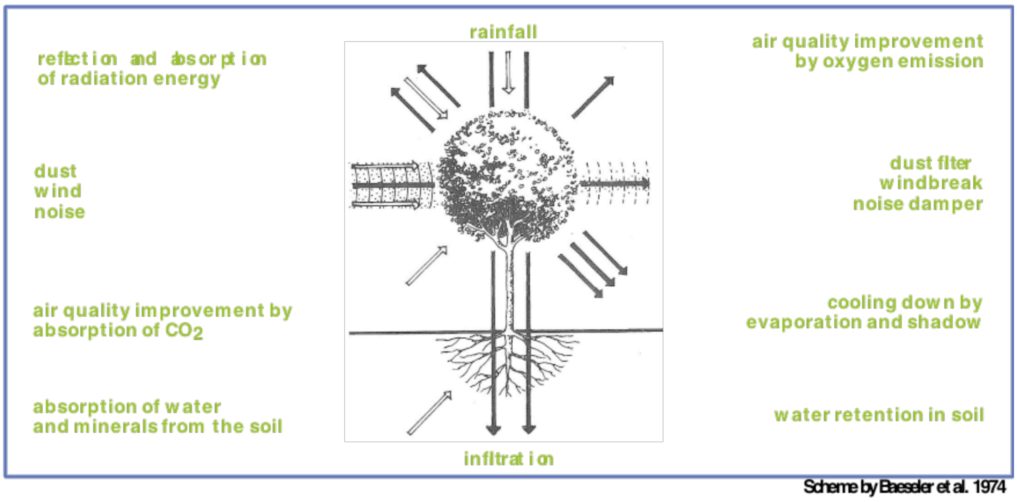


Fig. 1: Indicator function of urban green space for selected ecological functions (source: Arlt et al. 2005 after Baeseler et al.1974)

Basically, the type and extent of landcover influences ecological performance. To quantify the impact of various types of landcover on the environment, selected ecological land functions and landcover types of sealed, unsealed vegetation-free areas and unsealed vegetated areas were analysed and assessed (Heber, Lehmann 1996). The assessment procedure assigned dimensionless ecological performance parameters to types of landcover. The ecological performance of an area is assessed on an ordinal scale from 0 (no ecological performance) and 1 (very high ecological performance).

The functions climatic compensation, dust filtration, pollutant retention, porosity and permeability, groundwater replenishment, rainwater infiltration, and biotope formation were assessed for lawn, meadow, and perennial cover as well as trees and shrubs and open ground as vegetationless land.

Low to high ecological performance was recorded for all vegetated areas and open ground areas. Vegetated areas are most efficient in climatic compensation, porosity and permeability of the soil, rainwater infiltration, pollutant retention, and biotope formation (except for lawn surfaces). Lawn, meadow, and perennial cover showed low to medium performance in binding dust and replenishing groundwater. Areas with tree and shrub cover contribute least to groundwater intake but are the most efficient when it comes to dust filtration.

3 Empirical Studies

3. 1 Subject of Study

A research project at the Leibniz Institute of Ecological and Regional Development addressed the empirical-deductive determination and assessment of green space and volume in cities and urban regions. The basis was a GIS vegetation structure analysis of 116 urban districts and selected surrounding communities.

The empirical investigation focused on an impact analysis of relations between land use structure and the proportion of green space and area-specific vegetation volume. Regional statistical procedures were used.

The fundamental methodological tool was the comparative city study. It addressed ordinal scaled measurement of vegetation levels (low, medium, and high) on the basis of the proportion of green space and area-specific green volume. This involved urban typology studies on the basis of cluster analysis with the aim of identifying city types. Cities belonging to the same type show comparable proportions of green space and area-specific vegetation volume, which can be interpreted as ecosystem services and quality levels. They have largely similar use structures (for example, in settlement and traffic infrastructure, settlement density, area per inhabitant).

3. 2 Spatial Levels and Data Base

The vegetation structure analysis of 116 German cities addressed three spatial levels: the core city, the urban region, and open space.

The term core city refers to the city within its administrative boundaries.

The urban region includes the core city and selected surrounding communities.

The data base for determining vegetation structure in German urban districts is generated by the 1993 and 1999 Dresden urban biotope type maps, the 1997 urban structure type maps of the 116 urban districts, and land cover maps.

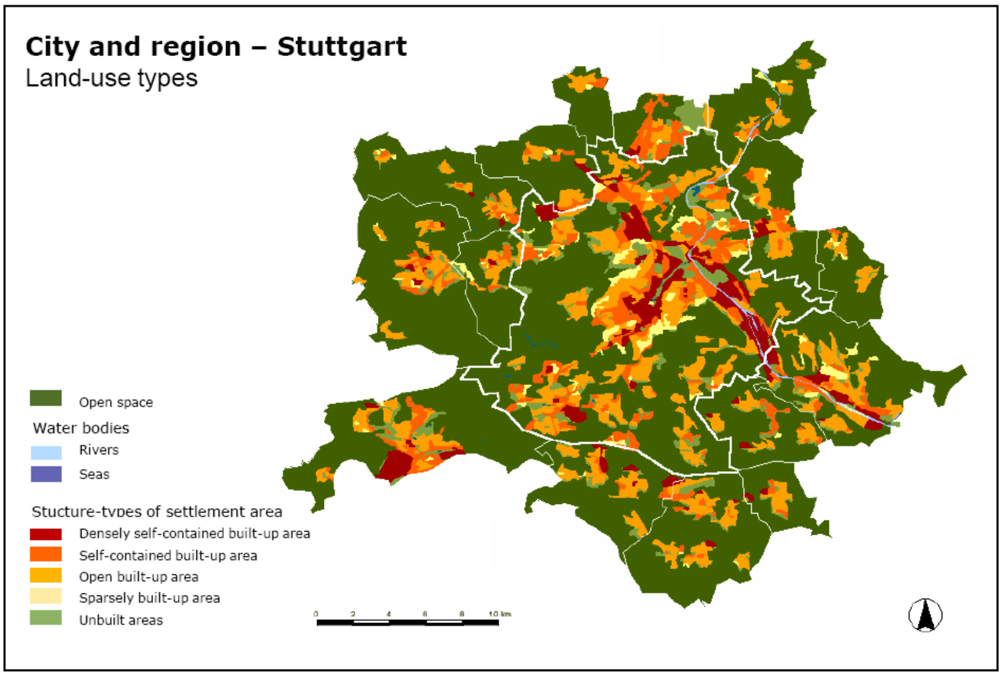


Fig. 2: Mapping of urban structure types, open space and surface water bodies. The example of the Stuttgart urban region (source: Arlt et al. 2005)

3.3 Method for Determining Green Space and Vegetation Volume

Of key importance in determining the proportion of green space and vegetation volume in German urban districts and urban regions are the urban biotope type and urban structure type approaches. For practical planning purposes, they enable a workable definition of vegetation structures and their assessment by type (classified units of public and private green space), dimensions (size and geometry of green spaces), and location (compactness and interconnectivity of green spaces).

From a biological point of view, the city consists of a mosaic-like multiplicity of biotopes. As a rule, they are clearly demarcated and internally relatively homogeneous. Urban biotope mapping provides a good overview of the biotope types and vegetation structures in a city. Vegetation structures were analysed and vegetation patterns determined on the basis of the urban biotope mapping of Dresden. 52 biotope types were identified, on the basis of which vegetation structures and volumes were assessed.

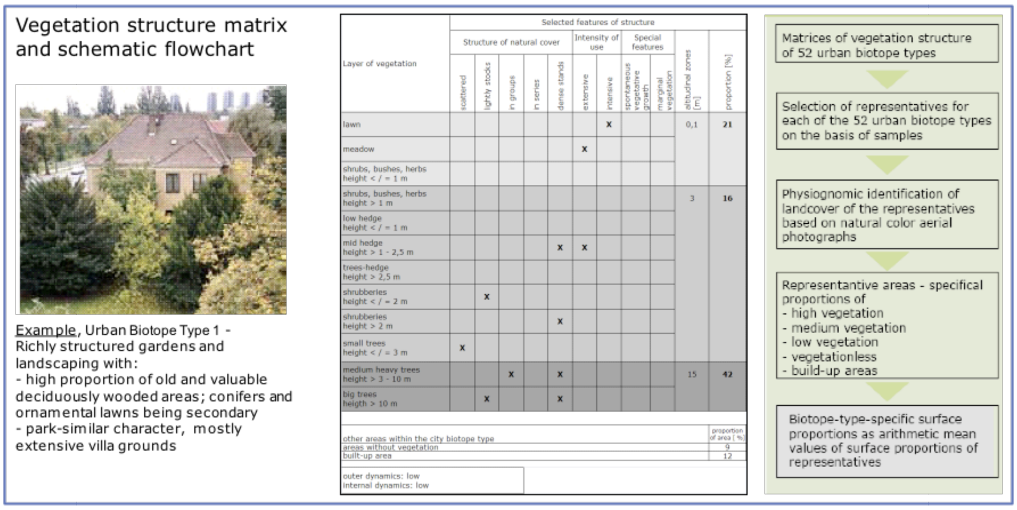


Fig. 3: Matrix of vegetation structure: example of the urban biotope type 1 (residential development, mixed uses, industrial, commercial and special purpose areas)and schematic flowchart of vegetation structural analysis (Arlt, et al., 2002)

The vegetation structure of urban biotope types was analysed in representative areas, analysis including the physiognomic identification of areas with low (≤ 1m), medium (≥ 1m to ≤ 3m), high vegetation levels ((> 3m), and vegetation less areas (built-up land, other sealed and open ground, water bodies).

4 Results of the Study of 116 German urban districts and their regions

In the context of the empirical studies, the vegetation structure analysis shows the proportion of green space and specific vegetation volume differentiated in terms of vegetation layer for the 116 German urban districts and their regions. The proportion of green space and specific vegetation volume are parameters which, on a medium scale (1: 25 000 to 1: 50 000), assist practical city-wide or urban regional planning. At the same time they serve to pinpoint deficiencies in the supply of green spaces at the district or neighbourhood level. In a model abstraction, green spaces and their cubature are two and three dimensional components of the physical urban space and, in interaction with sealed areas, surface water, and buildings, fundamentally affect the material, energetic, and informational state of the urban living environment. Physical urban structures are influenced by land-use structures.

4.1 Proportion of Green Space and Specific Vegetation Volume

The proportion of green space refers to the percentage share of vegetated areas in the core city, the urban region, the settlement area, and open spaces as a whole and differentiated by layer as "low," "medium," and "high."

Specific vegetation or "green" volume refers to the volume of vegetated areas in relation to given units of area (as a rule 1 m²) in the core city, urban region, settlement area, or open space. It is differentiated by vegetation layer into "low," "medium," and "high" and expressed in m³ per m² for the sum of vegetation layers.

Data on the urban ecological parameters green space and vegetation volume differentiated by spatial level and vegetation stratification are available for 116 German urban districts and as mean values for all cities.

Spatial units	Proportion of green [%] by vegetation layer				Specific green volume [m³/m²] by vegetation layer			
	low	medium	high	total	low	medium	high	total
City total	47	11	20	78	0,29	0,24	1,97	2,52
City area of settlement	4	6	17	26	0,15	0,21	1,57	1,92
City open space	55	11	22	89	0,38	0,26	2,15	2,80
Region total	53	10	21	84	0,36	0,24	2,00	2,61
Region area of settlement	33	10	15	58	0,15	0,22	1,59	1,95
Region open space	59	10	22	92	0,41	0,25	2,11	2,79

Tab. 1: German urban districts – mean proportion of green space and specific vegetation volume differentiated by spatial level and vegetation layer (source: Arlt et al. 2005)

Against a backdrop of progressive land take for settlement and transport purposes, the quality of the living environment is increasingly reflected in the type and extent of **green space in settlement areas**. Owing to the long period people spend in the settlement area and its relatively poor experience value, the ecological and psycho-social functions of green space in urban settlement areas are more greatly appreciated than those of open terrain.

In the settlement areas of core cities, the average proportion of green space is about 25 %. The proportions by vegetation layer are 5 % (“low”), 5 % (“medium”), and 15 % (“high”). In the settlement areas of urban regions, there is a markedly higher proportion of green space, on average 60 %; 35 % with a “low” vegetation coverage, 10 % with “medium” coverage, and 15 % with “high” coverage.

Vegetation volume relative to a square metre unit and the spatial units core city and urban region is not a sensitive indicator. Changes in green volume caused by urban development measures at the neighbourhood or plot level are hardly shown by city-wide or urban regional statistics, although the micro-climatic impact of such changes can be considerable. Specific vegetation volume on the medium spatial scale is rather to be seen as a basic municipal indicator which – generally in connection with soil sealing – provides a “rough” pointer of urban ecological quality.

4.2 Interaction between Urban Structure, Green Space and Vegetation Volume

Impact analysis was based on regional statistics research, and selected structural and phenomenological parameters were included. Sub-studies were conducted within the circular causal connection between processes, structures, and phenomena. They addressed interaction between urban and land-use structures and green spaces and vegetation volumes differentiated in terms of vegetation layer. Correlations were shown and incorporated in stochastic models. Relevant regional statistical methods were used in the studies on interaction between urban and land-use structures, green space and volume. The regional statistics programme was developed against a backdrop of accepted and plausible circumstances.

Stochastic models were developed on the basis of factors and parameters to calculate the proportion of green space and vegetation volume in both core cities and urban regions. The high coefficients of determination make the models highly relevant for planning practice. Taking the land cover data (for the 5 parameters) as input for the model will be sufficient to calculate the green volume and proportion of green space for any German city. It might be possible to adapt the model for other countries.

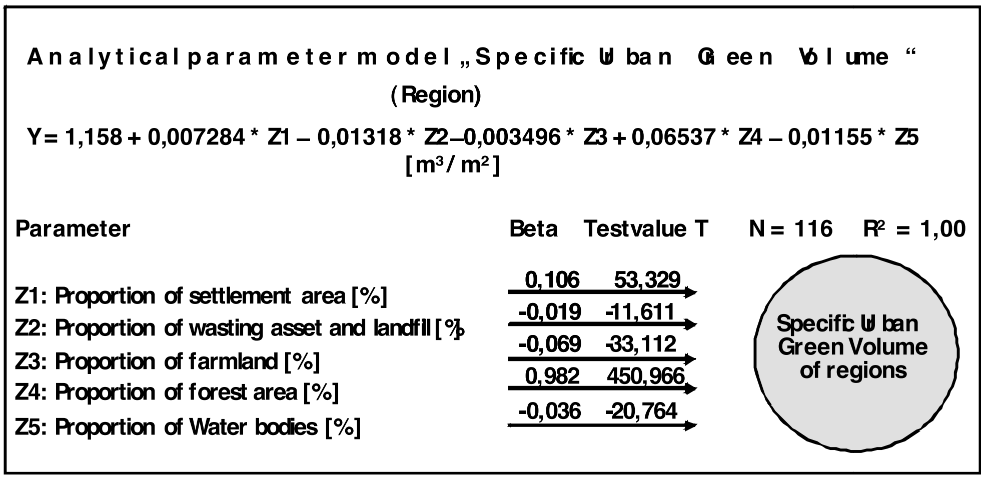


Fig. 4: Analytical parameter models "proportion of green space" for core cities and "specific green volume" for urban regions (source: Arlt et al. 2005)

5 City Clusters

City clusters enable complex circumstances to be structured and substance lent to complex concepts like "sustainable urban development." Through cluster analysis as a multivariate procedure, the parent population of urban districts was divided in terms of several characteristic variables into types (clusters) in such a way as to make the similarities between cities of a given type and the differences between cities of any two types as great as possible.

Such cluster analysis takes account of the proportion of green space, vegetation volume, degree of surface sealing, and the proportion of surface water bodies – use-structural parameters that relate to selected elements of the physical urban space. Apart from these statistical parameters of land-use structure, function performance and efficiency depend very strongly on the spatial structure of urban land.

The analysis identified clusters of cities with characteristic quality standards and attribute structures. This permits land-use structures to be identified, described, and assessed from a qualitative perspective.

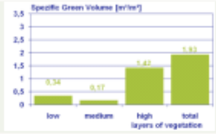
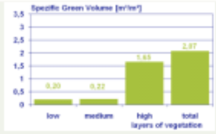
Cluster	Patterns	Urban Green Volume	Proportion of
I	Ham 		• urban green space: 66,5 % • surface water: 8,1 %
II	Magdeburg 		• urban green space: 75,5 % • surface water: 6,0 %
III	Lübeck 		• urban green space: 71,7 % • surface water: 14,1 %
IV	Brandenburg 		• urban green space: 73,4 % • surface water: 18,8 %
V	Schwerin 		• urban green space: 60,5 % • surface water: 28,8 %

Fig. 5: City clusters from an ecological perspective – characteristic vegetation patterns with vegetation volumes and the proportion of green space and surface water for clusters I to V (source: own processing)

6 Conclusion

Green and open spaces perform ecological functions.

The type and extent of green space and vegetation volume in cities and urban regions interact with land-use structures and the spatial structuration of uses.

Urban vegetation volume is a highly aggregated indicator of many aspects of ecosystem services in the urban living environment (especially in bioclimatic balance and air hygiene), whose function is to be seen as providing a rough intimation of city-wide ecological quality.

Cognizance of interaction within the structure of uses enables action to be taken to influence ecological performance and quality in urban settlement areas.

Differentiated preferences in urban development create differences in land-use structure and thus in the characteristic ecological setting of a city. These framework conditions require a range of strategies and the differentiated use of tools and programmes to secure and develop the supply of urban green spaces and ecological quality.

7 References

Arlt, G., Fürll, L., Hennersdorf, J., Kochan, B., Lehmann, I., Mathey, J., et al. (2002). *Stadtökologische Qualität und Vegetationsstrukturen städtischer Siedlungsräume* (Bde. IÖR-Texte 139). (Leibniz-, ed.) Dresden.

Arlt, G., Gössel, J., Heber, B., Hennersdorf, J., Lehmann, I., & Thinh, N. (2001). *Auswir-kungen städtischer Nutzungsstrukturen auf Bodenversiegelung und Bodenpreis* (Bde. IÖR-Schriften 34). (L.-I. f. e.V., ed.) Dresden.

Arlt, G., Hennersdorf, J., Lehmann, I., & Thinh, N. (2005). *Auswirkungen städtischer Nutzungsstrukturen auf Grünflächen und Grünvolumen* (Bde. IÖR-Schriften/Band 47). (L.-I. f. e.V., ed.) Dresden.

Baeseler, H., Gelbrich, H., Greiner, J., Stefke, E., & Thiemann, H. (1974). *Grünanlagen im Wohngebiet.* Berlin: Bauakademie der DDR, Institut für Städtebau und Architektur.

Bruse, M. (2003). Stadtgrün und Stadtklima. *LÖBF-Mittelungen 1* , 66-70.

Doetsch, P., & Rüpke, A. (1997). *Revitalisierung von Altstandorten versus Inanspruchnahme von Naturflächen. Gegenüberstellung der Flächenalternativen zur gewerblichen Nutzung durch qualitative, quantitative und monetäre Bewertung der gesellschaftlichen Potentiale und Effekte.* Im Auftrag des Umweltbundesamtes.

Finke, L. (1994). *Landschaftsökologie – Das Geographische Seminar.* Braunschweig.

Hege, H.-P., Lausterer, H., Scheffler, V., & Schwarting, H. (1998/99). Verbesserung des Stadtklimas durch Grün – Wirkungen, Planung und Umsetzung - Seminarpapier. *Instrumente der ökologischen Planung, Stadtklima 21.* Universität Kaiserslautern, Lehr- und Forschungsgebiet Ökologische Planung und UVP; WS.

M. Großmann, M., Pohl, W., & H.D. Schulze, H. (9 1983). Grünvolumenzahl und Bodenfunktionszahl in der Landschafts- und Bauleitplanung. *Schriften der Behörde für Bezirksangelegenheiten, Naturschutz und Umweltgestaltung* .

Miess, B., & Miess, M. (10 1997). Materialien zur Grünordnungsplanung – Teil 1: Siedlungs-ökologische und gestalterische Grundlagen. (L. f. Umweltschutz, ed.) *Schriftenreihe Untersuchungen zur Landschaftsplanung* .

Nohl, W. (1993). *Kommunales Grün in der ökologisch orientierten Stadterneuerung* (Bd. Handbuch und Beispielsammlung. Studien). (IMU-Institut, ed.) München, 19.

Schulte, W., Sukopp, H., & Werner, P.-A. ". (10 1993). Flächendeckende Biotopkartierung im besiedelten Bereich als Grundlage einer am Naturschutz orientierten Planung – Programm für die Bestandsaufnahme, Gliederung und Bewertung des besiedelten Bereichs und dessen Randzone. *Natur und Landschaft* , 491-526.

Wiener Umweltanwaltschaft (WUA). (2001). Wozu brauchen wir Bäume in der Stadt? *WUA-News* .

8 Figures and Tables

Towards an urban ecosystem sustainability assessment tool

Karima Dakhia, Prof. Ewa Berezowska-Azzag

Polytechnic School of Architecture and Urban Planning, Algeria

The pursuit of sustainability in urban environment requires the implementation of a sustainable urban planning. Urban planners and decision makers need assessment tools to assess the sustainability of cities and monitor their progress toward that goal. This task represents a challenge for urban planners, since cities are studied now as complex organisms. From urban planning to urban ecology, the city is no longer a built and a natural environment to be analysed through their mutual impacts. The city is an urban ecosystem that has a metabolism. Any assessment of sustainability of the city means the assessment of sustainability of both: the urban ecosystem and urban metabolism.

In this paper we will use the systemic approach to build a model of a city as a complex system: the urban ecosystem, in order to understand its structure and function, hence understand its metabolism. The urban metabolism is made of a dynamic cycle of flows that nourish the city and reject its wastes. The web of input and output flows woven by cities spreads well beyond urban ecosystem natural hinterlands to neighbouring and remote natural ecosystems. Using the systemic model, we can indicate the state of sustainability of the urban ecosystem and evaluate its metabolism during the given period. The sustainable city is the one that succeeds to control its metabolism to keep it closer to the natural balance value in order to respect the hinterland carrying capacity. Thus, assessing the sustainability of any urban settlement needs to assess the urban metabolism compared to its state of sustainability with adequate tools integrated in an ongoing planning and monitoring process.

Among the available metabolism assessment tools the ecological footprint is already used for urban metabolism assessment, but this tool, developed essentially from an environmental economy point of view, is not suitable for answering the urban planning needs. In fact, it assesses and quantifies the needs to natural environment services. It assesses the overshot in consumption compared to the available natural carrying capacity, but offers no vision on what to do to correct the overshot. Urban decision makers need tools to assess urban ecosystem sustainability compared to a well defined limit value of sustainability and help define the specific actions which need to be done to reach it, and then to monitor the situation progress towards sustainability.

In this paper we will propose a tool that will complete the ecological footprint in the assessment of the urban metabolism in order to reach a sustainable urban ecosystem within an urban planning process.

Keywords: assessment tools, complex systems, ecological footprint, sustainability assessment, urban planning

1 Introduction

Urban sustainability assessment tools have been developed to assess and monitor the progress towards sustainability of an urban built environment of a scale of a neighbourhood or a city. The city is defined as a socio-economical built environment and so the tools are dedicated to assess the sustainability of the built environment, transport, water and sewage, or economical and social impacts. These tools, such as, Sustainable Renovation of Buildings for Sustainable Neighbourhoods (HQE^2R), or Comprehensive Assessment System for Building Environmental Efficiency (CASBEE for urban environment), Cost Benefit Analysis (CBA), Life Cycle Cost Analysis (LCCA), are developed to answer particular sustainability objectives for a given city. These tools lack at addressing the sustainability evaluation of a city as an urban ecosystem.

Any sustainability assessment of an urban ecosystem would have to address the sustainability of its urban metabolism. The tools that fulfil this goal are assessment tools borrowed from new disciplines, such as urban ecology, industrial ecology, and environmental economy. The tools: Material flow analysis (MFA), Life Cycle Assessment (LCA), rucksacks and the ecological footprint (EF)… evaluate material consumption and wastes disposal of a given urban metabolism.

The Ecological footprint is one of these tools it has been proposed by Wackernagel and Rees in the late 90s to the environmental economy field. It measures the natural services consumed by an urban ecosystem compared to the carrying capacity of the natural environment that sustains it (Wackernagel, Rees, 1998). The tool quantify the input (the demand side) and consequently the output flows and converts the results into the needed natural global land to provide such resources demand compared, to the available natural bio-capacity land and compared also to the land surface of the actual urban ecosystem (Wackernagel, Rees, 1998). Different sectors from the built environment can be considered in this way: housing, industry, services, transport, wastes (Wiedmann et al., 2003). The ecological footprint value is generally converted into lands of carbon absorption, built up land, forest, cropland, grazing land, fishing ground. The ecological footprint is “a framework for sustainability planning in the public private domain” (Wackernagel and Yount, 2000). It can be used at city level (citylimits London), municipality level (Wilson and Anielski, 2004) as well as household scale (Wiedmann et al., 2003). In the case of the new eco-city of Dongtan for example, the ecological footprint has been used as a strategic planning tool in the developing of the city master plan. (Birch, 2007).

So far, the ecological footprint is a useful tool to “visualize” any city’s consumption of natural services comparing to the carrying capacity available to be either in a deficit or reserve case. It can also alter urban design options. (Wackernagel, Yount, 2000). This visualization is useful for comparison. In a strong sustainability scenario, it can define the local or global carrying capacity value as a limit to which the urban ecosystem metabolism has to refer to. It allows us to understand where we are in terms of natural services consumption comparing to the available ones.

At a nation level a comparison can be made between the ecological footprint of a given city and the ecological footprint of the country. A comparison of all cities ecological footprint would allow classing cities from the least to the most sustainable, in the national or even international scale.

Compare different metabolisms and classify them from the highest to the lowest will show also which one needs to be approached first, in order to recover a sustainable value. We can compare here the cities or the districts metabolism, pinpoint the weak city or district responsible of the "bad" metabolism, and make them take proper actions. By comparing the urban metabolism value to the sustainability value of the carrying capacity limits we evaluate the gap to be bridged. We can also set scenarios on the long run and monitor progress toward that value.

From an urban planning perspective, any sustainability assessment is done in order to plan urban actions that will correct the lack of progress towards sustainability. Thus the ecological footprint tool appear to be not sufficient because urban planning discipline needs tools that helps not just analyzing or measuring the metabolism, but also planning and controlling it by proposing planning scenarios, adopting programs with local urban actions

In this study we will propose a new tool to be added to the ecological footprint in order to constitute a complete decision making tool for urban metabolism sustainability assessment, management and control. We would adopt a systemic approach to develop a complex system model for the urban ecosystem. This abstract model would help us understand the mechanism of the urban metabolism.

2 Planning approach method by building an abstract complex model of the urban ecosystem and its metabolism

It is important to define the urban ecosystem and define its limits. As an ecological concept, the ecosystem is a natural habitat biologically independent from its environment that rests in state of equilibrium thanks to the interactions of all its inhabitants divided into consumers and producers of natural services.

According to Rees the term of ecosystem appears to be inappropriate for the city because in ecosystems "…producers and consumers organisms (particularly micro-consumers) coexist in a mutually interdependent obligatory relationship which ensures a cascade of energy and the continuous recycling of essential chemical nutrients through the ecosystem." (Rees,2003). In the city though, the majority of organisms who participate in sustaining city life are beyond the limits of the urban built environment space. The urban ecosystem is certainly not just the city but something wider enough to encompass "…the total natural capital and flows on which a city depends to meet the long-term needs of its inhabitant" which is called by Alberti "the urban ecological space" (Alberti, 1996).

Second, the metaphor of urban metabolism drawn from biology was first quoted by Wolman in 1965 "The metabolic requirements of a city can be defined as all the materials and commodities needed to sustain the city's inhabitants at home, at work and at play." (Wolman, 1965). The city is compared to a living being which has a metabolism consuming resources and transforming them into rejected wastes in a continual production process.

To outline the abstract model of the urban ecosystem with its metabolism we draw on the systemic theory of Joel de Rosnay (Rosnay, 1975). From a systemic view, the urban ecosystem is a complex open dynamic system composed of a structure and a function of dynamic of flows. The system, in its functional dynamic, pursue the stationary balance between stocks and sinks level. In other words, the urban ecosystem searches for a balance between the capacity of the natural environment to answer the urban ecosystem needs and its demand for natural services.

The structure of the urban ecosystem represents its organization on space. It is composed of limits, elements, stocks, and communication network. The function is composed of flows, valves, feedback, and delay. The urban ecosystem through its flows is in continual motion from the stocks to the sinks that are both located in the hinterland or natural environment. The system is in a stationary balance if the stocks and sinks level keep balanced despite the flow dynamic. The balance is preserved thanks to the action of the valves that control the flows motion. The valves reduce or increase the flows according to the feedback action as the following scheme shows (Figure 1).

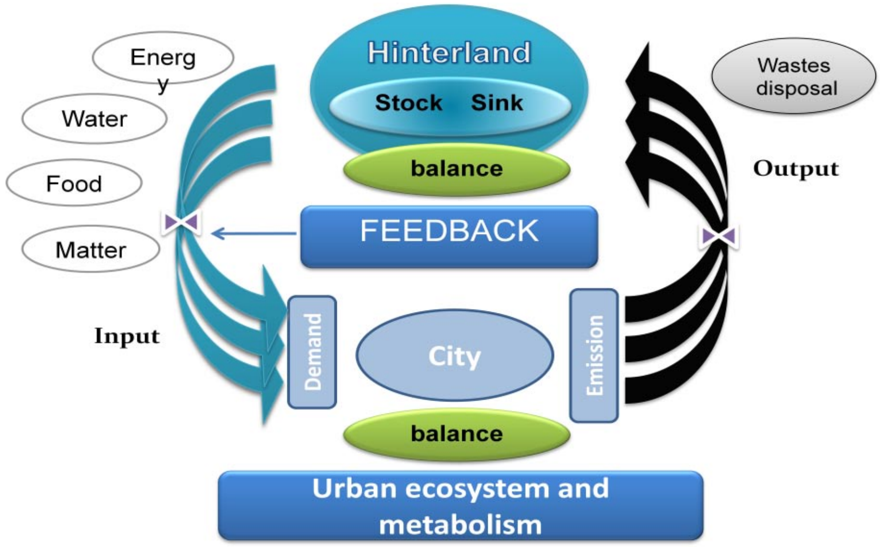


Figure 1: Urban ecosystem and metabolism model

The functional dynamic of our urban ecosystem model with its input flows and its transformation in output flows, represent in fact the so-called urban metabolism.

Hence, a sustainable urban ecosystem is the one that keeps a balanced dynamic of flows between stocks and sinks, in other words a metabolism within the limits of the natural environment carrying capacity.

Of course, in order to control the urban metabolism we need to measure it with the Ecological Footprint tool, used already in several regions around the world. Adopting the ecological footprint tool to our urban ecosystem model will convert the source and sink of the natural environment into the ecological footprint of the city with its different lands (carbon absorption, built up land, forest, cropland, grazing land, fishing ground).

All complex living systems are in fact intelligent systems that integrate in their structure a controlling mechanism which helps the system to regulate its metabolism to meet a balance with its surrounding environment. This mechanism represented by the valves and feedback is the intelligent regulatory centre of the system. Likewise the urban ecosystem is an intelligent system, it must have an intelligent regulatory centre we call the "metabolism control centre".

If the urban metabolism values of a studied urban ecosystem fail at reaching the target balance, it means that the "metabolism control centre" is deficient. If we want to change, alter or correct the urban metabolism, we have to control the dynamic of flows through the "metabolism control centre" where decision is taken. And thus to plan urban ecosystem towards sustainability we need to analyze, simultaneously, the dynamic of flows of the metabolism and the capacities of the "metabolism control centre".

In many cases, from municipality scale (Anielski, 2004) to home scale (SEI, 2003), the use of the ecological footprint is not yet integrated beyond the diagnosis stage of urban planning. Nevertheless, it tells where is the problem and what we should stop doing. But, the EF gives no information on the metabolism control: why is it deficient, and what to do to make it efficient in controlling the metabolism balance. So, we need to integrate a second tool to measure the "metabolism control centre" capacities, as the following figure shows (Figure 2).

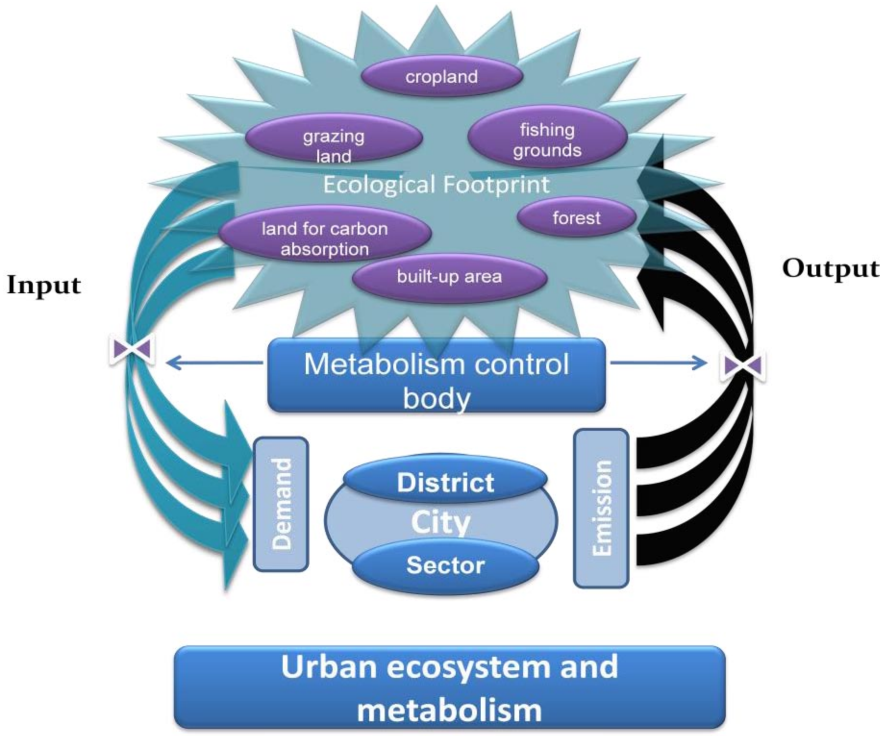


Figure 2: urban ecosystem model with EF and metabolism control centre

3 Missing tool of a metabolism control as a result of urban ecosystem functions analysis

In order to assess the sustainability of an urban ecosystem, we need to assess at the same time the urban metabolism dynamic of flows with the metabolism control centre. The tool we propose is the one that will help decision makers to visualise at the same time the ecological deficit of the urban metabolism with the mechanism of the metabolism control centre. To fulfil this mission, we propose a second tool, additional to the ecological footprint, we call the "the Institutional Ecological Footprint" (IEF) and which represents the ecological institutional profile of the urban ecosystem.

This tool will indicate for each sector measured by the ecological footprint, its institutional capacity profile. The IEF will focus on institutions, instruments, laws and programs (or project) addressing the control of the given sector, as well as on the public/private participation process. It will indicate first whether they exist or not, and second, if existing, the tool will evaluate their actions on the metabolism control for each sector to be persuasive, incentive or regulatory.

For participation the evaluation would be on the level of public/private participation from none to effective participation in decision making.

To build the IEF a matrix is set from the sectors concerned by the EF analysis and the elements of the institutional frame of the metabolism control centre as in the chart (Table 1).

The EF analysis sectors are: Energy, Water, Wastes, Matter, Transport, Built land.

The IEF analysis points are :

- Institutions: all public or independent organisms that are in charge of the control of the flows for a given sector responsible of a high EF.
- Laws: all legal texts that have for objective to control or reduce the flow of a sector responsible of a high EF.
- Instruments: all legal instruments that are used by institutions to control and reduce the flow of a given sector responsible of a high EF.
- Standards: sustainability or limit values for a given sector or flow.
- Programs: all programs or projects that are initiated in order to reduce the flow of a given sector responsible of a high EF.
- Public participation: all forms of public/private participation in the decision making process for the above institutional elements.

The institutions, laws, instruments and programs will be evaluated according to their strength of application in the urban metabolism control. The evaluation level is expressed by values from 0 to 3 according to the following criteria:

- 0 : Missing: when there is no existing action
- 1: Persuasive : When the action aims only at showing the negative points due to the high level of EF for each sector and explain the possible dangerous consequences for the urban development. Leaflets and documentaries are edited or conferences organised to raise awareness among public opinion and concerned actors.
- 2: Incentive: When the action aims at inciting people, enterprises and investors to compel to the recommendation of flow reduction by the implementation of measures such as fiscal and financial instruments or pollution fees.

- 3: Regulatory: when the action is to strongly reduce the flow responsible of

	Transport	**Energy**	**Wastes**	**Matter**	**Water**	**Built land**

high EF by implementing regulatory measures such as fiscal, legal instrument and permits, land use control, urban planning control, emission standards...

For the public participation the evaluation level is expressed from 0 to 3 for different criteria:

- 0 : Missing: no public participation
- 1 : Public information: at this level all institutional process is not directly accountable to the public opinion which have only the right to be informed.
- 2 : Public consultation: the public is informed and is given the right to give his opinion for different issues but there is no obligation by the authorities to adopt their opinion.
- 3 : Public participation: the public is consulted but also participate in the decision making process.

Instruments: 0. Missing 1. Persuasive 2. Incentive 3. Regulatory						
Institution: 0. Missing 1. Persuasive 2. Incentive 3. Regulatory						
Laws: 0. Missing 1. Persuasive 2. Incentive 3. Regulatory						
Standards: 0. Missing 4. Persuasive 5. Incentive 6. Regulatory						
Program – project 0. Missing 1. Persuasive 2. Incentive 3. Regulatory						
Public participation 0. Missing 1. Public Information 2. Public Consultation 3. Public participation in decision making						

Table 1:The IEF matrix

The information collected will be translated from the matrix (Table 1) to the AMOEBA graph. The assessment is than visualised and we are perfectly able to judge which actions are needed to improve the metabolism balance, like in the scheme below (Figure 3).

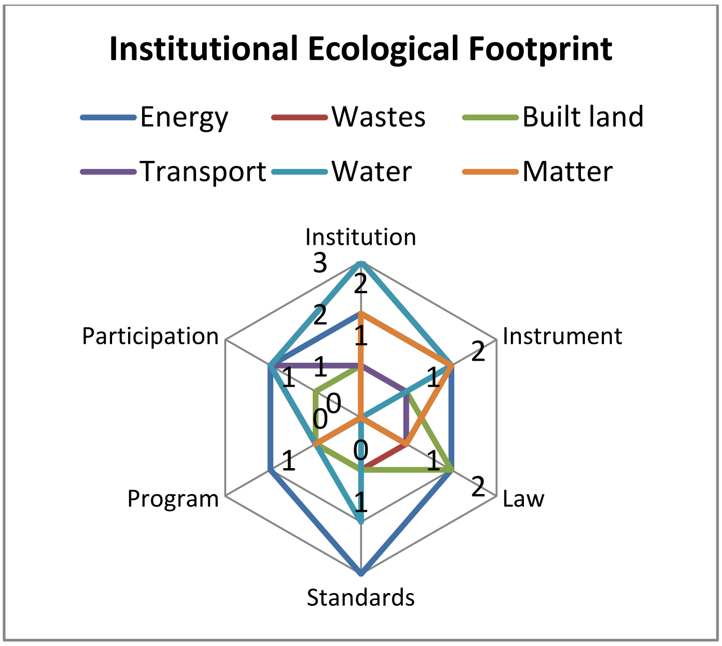


Figure 3: IEF AMOEBA

4 Institutional Ecological Footprint capacities discussion

The ecological footprint associated to “the Institutional Ecological Footprint” will form the “Urban Institutional and Ecological Footprint” tool which is a strategic controlling and planning tool for the urban ecosystem. This tool will give a diagnosis of the urban metabolism compared to the limit of the carrying capacity of the natural environment. Through the EF, it helps visualize the gap towards balance and through the IEF gives a diagnosis of the “metabolism control centre” that will help us to understand where, the deficiencies of this structure in controlling the metabolism, lies and how they can be corrected.

This tool answers the fundamental questions for urban ecosystem sustainability:

How far is the urban metabolism from sustainability state? And what flows are responsible of the unsustainable state?

Why is the “metabolism control centre” unable to control the metabolism? and what has to be done, at both levels: urban metabolism and metabolism control centre, to achieve sustainability?

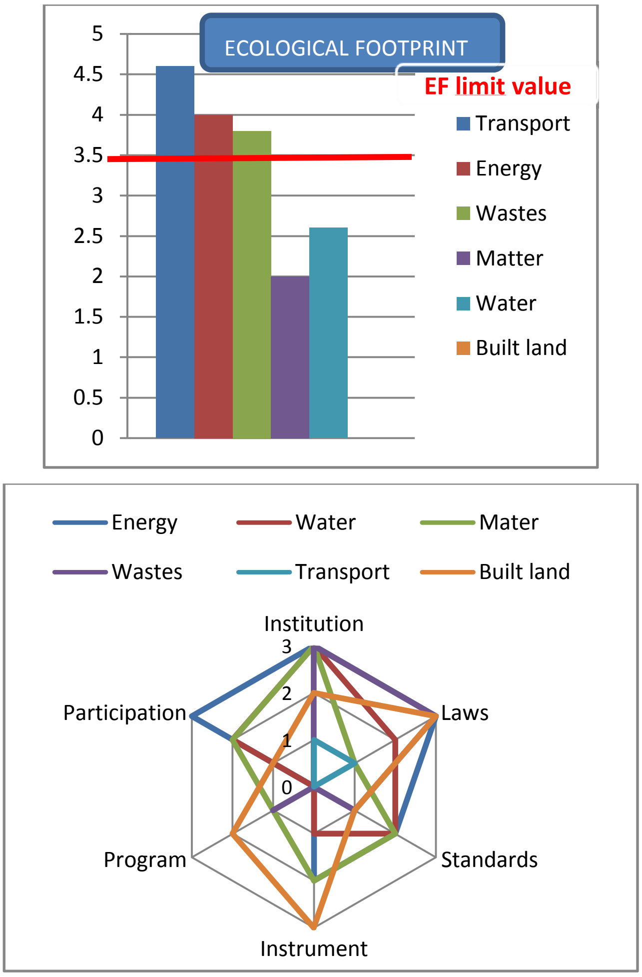


Figure 4: Example of the UEIF represented by the two footprints the EF and the IEF

The UIEF tool clearly pinpoint the problem and the possible solutions, who will do it (which are the stakeholders to be involved) and in which way. It gives the ecological footprint an institutional basis to its application at local level that will help in decision making and action taking because it gives information, simultaneously, on the metabolism overshoot for a city or district and the institutional structure in charge of the control of the urban metabolism.

This strategic tool allows also the comparison between sustainability level of two or more cities by comparing their EF and their IEF. The comparison will make it easier to visualise the reasons of ecological deficits for one and healthy metabolism for other.

The urban ecological and institutional footprint UIEF tool introduces the urban metabolism approach in the urban planning process and in the city institutional framework. The sustainability assessment of the urban ecosystem would be done through the assessment of the metabolism by the EF and through the assessment of the metabolism control centre by the IEF. After assessment, scenarios and programs would be drawn for integrated actions to reduce EF and control the metabolism. Actions on the metabolism control centre and on the flows will follow, located in space and time with ongoing monitoring and feedback (Figure 4).

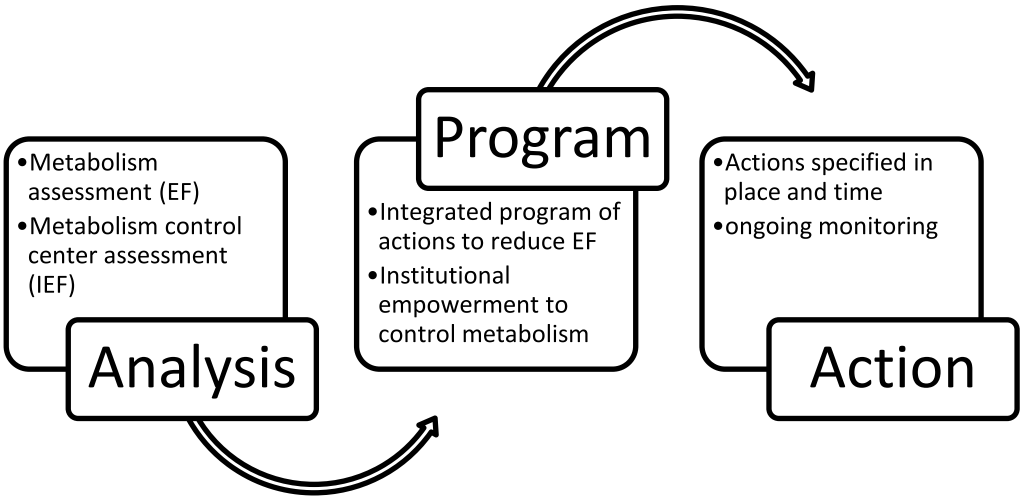


Figure 5: Integration of the EF and IEF in the urban planning process

The implementation of the UIEF tool requires its integration in an urban ecosystem planning process by a multidisciplinary team work. This assessment tool is dedicated to urban metabolism and so requires changes in: paradigm through an integrated multidisciplinary approach, and in institutional framework through the empowerment of the control metabolism centre.

5 Conclusion

The existing urban assessment tools address the city as a sum of different parts. The city considered as an urban ecosystem requires a holistic tools to assess the urban metabolism and help the decision making for controlling it. The available tools to measure the urban metabolism, such as the ecological footprint, lack at giving information on the urban metabolism control level. The ecological footprint measures the natural services needed by the city from the natural environment and convert it into lands. The urban planning discipline is about applying strategies and taking actions to achieve it. By analysing only the dynamic part of the ecosystem (flows), the ecological footprint fails understanding the laws that drives the urban metabolism and so fails at giving hints towards actions to be taken in order to keep it in a balance state. The present study aimed at bridging this gap by proposing a new tool the IEF that will allow the understanding of the institutional process responsible of the metabolism control. Associated to the EF this tool will form the UIEF which is a strategic assessment tool to be integrated in the urban planning process.

6 References

Alberti, M, & Lawrence Susskind. (1996). Managing urban sustainability: an introduction to the special issue. Environ impact assess rev, 16, 213-221.

Alberti, M, et al. (2003). Integrating Humans into Ecology: Opportunities and Challenges for Studying Urban Ecosystems. BioScience, 53(12), 1169-1179.

Alberti, M. (1997). Measuring urban sustainability. Elsevier Science Inc, ENVIRON Impact Assess Rev., 16, 381-424.

Alberti, M. (1999). Modeling the urban ecosystem. A conceptual framework. Environment and Planning B , 26(04), 605-630.

Alberti, M. (2000) An Integrated Urban Development and Ecological Simulation Model, Integrated Assessment, Vol 1, No 3, 215-227.

Barrett, John, et al. (2001). A Material Flow Analysis and Ecological Footprint of York. . SEI Stockholm Environment Institute.

Birch, Rachel. (2007). From Masterplans to Local Strategies - High and Low level Applications of the Ecological Footprint. In International Ecological Footprint Conference Stepping Up the Pace: New Developments in Ecological Footprint Methodology, Policy and Practice, 8-10 May 2007, Cardiff, UK, BRASS.

Brugmann, Jeb. (1996). Planning for sustainability at the local government level. Environ impact assess rev, 16, 363-379.

Collins, James P., et al. A New Urban Ecology Modeling human communities as integral parts of ecosystems poses special problems for the development and testing of ecological theory. American Scientist 88: 416-425.

Collins, Richard. (2007). Energy Footprints of Cork City Council's 'Sustainable City Campus'. In International Ecological Footprint Conference Stepping Up the Pace: New Developments in Ecological Footprint Methodology, Policy and Practice, 8-10 May 2007, Cardiff, UK, BRASS.

Dakhia, Karima, & Ewa Berezowska. (2005). Systemic model for a sustainable city . In (procs) "Environmental Sustainability: The Challenge of Awareness in Developing Societies", PLEA 2005, Beirut, Lebanon.

De Rosnay, Joel. (1975). Le macroscope. Paris: Seuil.

Girardet (1999), Creating sustainable cities, Schumacher society

Habert, H., Erb, K., & Krausmann, F. (2001). How to calculate and interpret ecological for long periods of time: the case of Austria 1926-1995. Ecological Economics, 38(1), 25-45.

Holden, Erling. (2004). Ecological footprints and sustainable urban form. Journal of Housing and the Built Environment, 19, 91–109.

Hurley, Joe, Ralph Horne, & Tim Grant. (2007). Ecological Footprint as an Assessment Tool for Urban Development. Paper presented at the Sate of Australian Cities conference, University of South Australia, 29th November 2007, retrieved from http://www.cfd.rmit.edu.au/content/download/590/5142/file/Hurley2007_footprint_paper.pdf.

Kitzes, Justin, et al. (2007). A "Constant Global Hectare" Method for Representing Ecological Footprint Time Trends. In International Ecological Footprint Conference Stepping Up the

Pace: New Developments in Ecological Footprint Methodology, Policy and Practice, 8-10 May 2007, Cardiff, UK, BRASS.

Newman Peter, (2006). The environmental impact of cities. SAGE Publications, 18(2), 275–295.

Pickett et al. (2001). Urban Ecological Systems: Linking Terrestrial Ecological, Physical, and Socioeconomic Components of Metropolitan Areas. , Vol. 32, 127-157.

Piracha Awais L & Marcotullio Peter J, 2003. Urban Ecosystem Analysis, Identifying Tools and Methods, United Nations University Institute of Advanced Studies.

Rees, William E.. (1992). Ecological footprints and appropriated carrying capacity: what urban economics leaves out, Environment and Urbanization 1992; 4; 121-130

Rees, William E.. (1996). Urban ecological footprints: why cities cannot be sustainable and why they are a key to sustainability. In Environ Impact Assess Rev, Vol 6; Issue.6, 223-248

Rees, William E.. (2003). understanding urban ecosystems: An ecological economics perspective. In Understanding Urban ecosystems (NewYork Springer-Verlag.).

Sheng Zhaoa, Zizhen Lib, & Wenlong Lia. (2005). A modified method of ecological footprint calculation and its application. Ecological Modelling , 185, 65-75.

UNU/IAS, 2003. Urban Ecosystem Analysis, Identifying Tools and Methods. retrieved from http://www.ias.unu.edu/binaries/UNUIAS_UrbanReport2.pdf

Wackernagel, M., & Rees W. (1999). Notre empreinte écologique, comment réduire les conséquences de l'activité humaine sur la terre" (écosociété.). Montréal.

Wackernagel, M., & Yount, J. D. (2000). Footprints For Sustainability: The Next Steps. Springer Netherlands., 2(1), 21-42.

Wackernagel, M. et al. (2006). The Ecological Footprint of cities and regions: comparing resource availability with resource demand, Environment & Urbanization, Vol 18(1): 103–112

Wiedmann, Tommy, John Barret, & Nia Cherret. (2003). Sustainability rating for homes - The ecological footprint component (p. 44). SEI Stockholm Environment institute.

Wilson, Jeffrey, & Mark Anielski.(2005). Ecological Footprints of Canadian Municipalities and Regions (p. 59). Canada: The Canadian Federation of Canadian Municipalities.

Wolman, Abel. (1965). "The metabolism of cities". Scientific American, V213(3), 179-190.

WWF, Living planet Report 2006, ZSL, Global Footprint Network.

Development of trade-off algorithm with AHP for building life cycle cost and building environmental assessment

Eugene Loh, Dr John Dean, Dr Tracey Crosbie, Prof. Nashwan Dawood

University of Teesside, UK

Sustainability and building cost are the main drivers in attempts to reduce building energy consumption. According to DEFRA (2004) the construction industry is one of the major contributors of CO_2 emissions that drive toward climate change. Carbon reduction becomes a global target and a goal has been set by the UK government to reduce carbon emission by 60% by year 2050.

The aim of this research is: 1) to predict and reduce the environmental impact of the building life cycle, the long term building operational and maintenance costs by developing a platform that allows trading off the output from different applications namely: Environmental Assessment Trade-off Tool (EATT), 2) Communicate/interact the result from EATT with stakeholders via a Building Information Modelling (BIM) server and 3D modelling.

3D-EATT is designed as a decision making tool for facility managers and environmental consultants, and will be utilised as a platform to allow materials trade-off with the Building Environmental Assessment, Life Cycle Assessment and Life Cycle Cost Assessment to compare the cost benefit of both sustainable and ordinary materials over a normal building life cycle of 60 years. These assessments are currently fragmented and do not comply with the idea of holistic sustainable assessment as suggested in Agenda 21.

An algorithm will be developed in this research for optimisation within the 3D-EATT tool. Literature review shows that the Analytical Hierarchy Process (AHP) method from the Multi-criteria decision analysis (MCDA) family is an ideal approach for the algorithm. As an outcome of the research, 3D-EATT will move the decision making process forward during the outline design process which, should allow a better optimisation result for stakeholders.

Keywords: 3D-Environmental Assessment Trade-off Tool, Analytical Hierarchy Process, Multi Criteria Decision Analysis

1 Introduction

Sustainability and building cost are the main drivers in attempts to reduce building energy consumption. The ratio of 1:5:200 is a key indicator of building life cycle costs where; 1 represents construction cost, 5 represents maintenance and building operation cost and 200 is the business operation cost. In other words, the building whole life cost is five times the construction cost. Effective building energy management therefore, has a significant impact on the reduction of the ratio factor 5.

Efficient facilities management is essential in the optimisation of energy use in buildings. However, the decision making process with a large number of variables involved in a complex process. Decisions involving multiple decision makers and differences in stakeholders' perspectives / preferences with plenty of options that partly satisfy the criteria for a successful project, is the most difficult area of the decision making process.

The lack of guidelines on how to interpret the monitoring information for data input and a lack of knowledge of the impact of data input changes are some of common factors influencing the quality of the decision making processes.

This paper will focus on the development of the trade-off algorithm of 3D-EATT. The prototype aims to demonstrate the process of running AHP in 3D-EATT and figures in the example might not be accurate.

2 Literature Review

2.1 Obstacles for Decision Making

Below are some of major challenges in decision making (Refsgaard et al 2007):

- Lack of guidelines to judge the monitoring information for data input

It is difficult to make an un-biased decision without the assignment of priorities and compromising weaker options when the term 'perfect decision' is varied for individuals/cases. For instance, if stakeholders looking for a building with better life cycle energy performance, concrete will be a better option whilst if initial cost is at the top criteria list, then a timber structure could be the choice.

- Difficulties in taking both qualitative and quantitative views of all stakeholders

When there are more than two decision makers, the decision process will be difficult as everyone has their own perspective/preference and plenty of options that partly satisfy the criteria.

- Lack of experience

Decision making is difficult if the decision makers do not have enough experience/knowledge. i.e. without enough knowledge in a materials character and its impact use in situ within the building, the planner will not priorities material implementation from a sustainability viewpoint.

2.2 The decision making approach: Multi-Criteria Decision Analysis (MCDA)

On most occasions, it is more difficult to make an absolute judgement than a relative judgement due to data uncertainty (Refsgaard et al 2007) or too many variables. The trade-off functionality of the Multi Criteria Decision Analysis (MCDA) tool creates an ideal opportunity to assist in finding an absolute answer for stakeholders.

Multi-criteria decision analysis (MCDA) also known as `multi-criteria decision aid' (MCA), `multi-criteria decision making' (MCDM) and `multiple criteria decision methods' (MCDM), (Mysiak J 2006).

MCDA with trade-off functionality may provide a solution for the decision making issues referred to section 3. There are various optimisation approaches available for implementation in environmental/energy sector, however, MCDA could offer the most potential for improving the decision making process. Indeed, MCDA works best in complex decision making processes.

The advantage of MCDA is that it is more efficient and will not add bias during the assessment process. The disadvantage is, it is complex and time consuming. Basson and Petrie (2007) used an MCDA tool to combine both technical and valuation uncertainties that were overlooked in the consideration of LCA and management processes.

Why trade-off? The term: 'trade-off' means to compromise some of many elements/aspects in order to gain a better result. This terminology is important to narrow and pin point the assessment criteria when there are many uncertain variable or multiple goals (Klastorin 2004).

In this research, MCDA is selected because it works well where problems are associated with finite numbers of criteria, with infinite alternatives or finite alternatives in implicit form (Fulop 2004, Steuer 1986).

2.3 FUNCTIONS FOR MCDA/MCDM

Due to the model complexity with environmental and social economic, trade-off with MCDA has been commonly used as a tool in the energy sector. MCDA has been applied for energy planning and policy for Environmental Impact Assessment (EIA), resource bidding systems, transmission and distribution systems, supply capacity planning, resource planning, generation system planning, measuring corporate environmental performance and national energy policy (Hobbs and Meier 2000).

2.4 FEATURES OF MCDA/MCDM

The features of MCDA are given below:

- It structure a framework for decision making

- It trade-off's sets of criteria

- It helps stakeholders to consider its potential use of alternative options

- It allows a better evaluation consistency in risk/uncertainty

- It helps to generate common interest from stakeholders' priority and in facilitates negotiation.

- It documents the decision processes to enable team communication (Hobbs and Meier 2000).

2.5 How to select the best MCDA method?

MCDA was selected due to its appropriateness to the research case. Although the MCDA approach appears to be an ideal tool to carry out trade-off, the selection process for the right MCDA method itself is fairly complex.

Figure 1 is the breakdown of the MCDA approaches and the three main classes of MCDA methods are:

"(1) value-oriented methods, which transform option performance into (perceived) value/utility (value/utility based methods, AHP),

(2) goal-orientated methods, which operate by seeking solutions that are as close as possible to stated (ideal) target values (goal programming), and

(3) outranking methods which weaken the properties of preference relation and incorporate incomplete and inconsistent preferences (ELECTRE, PROMETHEE) (Mysiak 2006*)."*

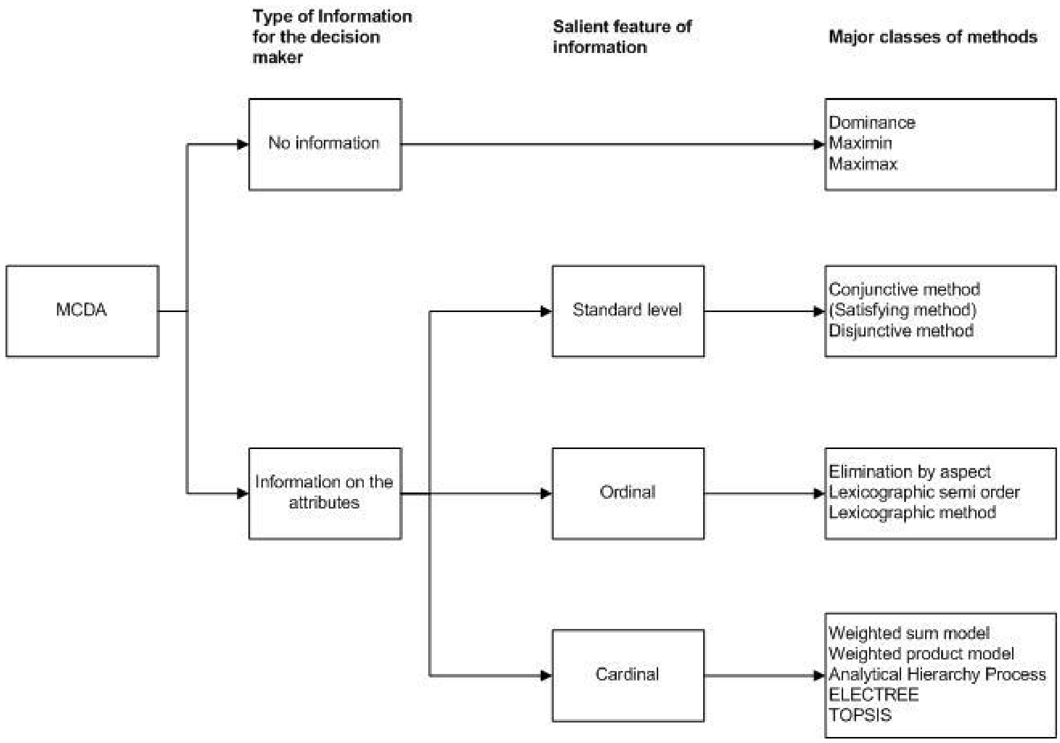


Figure 1: A taxonomy of MCDM methods (figure adopted from Chen 1991)

It is crucial for decision makers to select the right method, as a wrong choice of MCDA method may cause:

- A misleading solution;

- Wrong judgement that results a wrong decision making;

- Waste of time and resources;

- User lost confidence in the implementation of MCDA (Tecle, 1992).

The following criteria have been considered to select the right MCDA method:

- Thorough consideration of specific decision context (Buchanan, 1994; Hobbs and Meier, 1994; Olson, 1995)

- Understanding of decision problems and their alternatives (Salminen et al 1998)

- Understanding of different outcomes

- Understanding of conflicts between criteria

- Identifing uncertain data

2.6 Analytic Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is based on priority theory where, the elements within model are broken down into a hierarchy tree and a numerical value scaling from 1-9 is used to define the importance of each task. This method is usually applied for cases with limited criteria; in this case, 3D-EATT fits the AHP criteria.

Table 1 is a guideline of criteria priority assignation for decision makers. The feature of priority assignation is important because in reality, it was very difficult to construct a low impact and low cost building due to constraints in the project budget.

Table 1: Scale of relative importance for AHP (table adopted by Saaty 1980 c.f. Triantaphyllou 2000)

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgement slightly favour one activity over another
5	Essential or strong importance	Experience and judgement favour one activity over another
7	Demonstrated importance	An activity is strongly favoured and its dominance demonstrated in practice.
9	Absolute importance	The evidence favouring one activity over another is of the highest possible order of affirmation.
2,4,6,8	Intermediate values between the two adjacent judgement	When compromise is needed.
Reciprocals of above nonzero	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i.	

The benefit of AHP is that, it models complex preferences based on specific criteria set of the project that allows a smoother/easier decision making process.

Also Linkov et al (2006a) *suggest that AHP assumes that humans are more capable of making relative rather than absolute judgments, but at the same time allows room for the application of heuristic human reasoning and expertise.* Successful application of AHP has been reported from a wide range of research sectors for different purposes (Wong and Li 2008, Ho 2008).

Following is an AHP mathematical expression developed by Saaty (2001):

$Aw = nw$

A= alternatives

W=weighting/priorities

The matrix to examine the priority output is as follow:

$$\begin{pmatrix} W1 & W2 & Wn \\ W2 & . & . \\ . & . & . \\ Wn & . & . \end{pmatrix} \begin{pmatrix} w1 \\ w2 \\ . \\ wn \end{pmatrix} = n \begin{pmatrix} w1 \\ w2 \\ . \\ wn \end{pmatrix}$$

3 The prototype

The development of EATT is still in progress, the simple prototype below aims to demonstrate the process of running AHP in 3D-EATT. Initially, a simple Building Information Model was developed based on the data from the Byers Green primary school project in Durham (UK) (Loh et al 2007, 2008a, 2008b). This 3D model was devised using Autodesk Revit (figure 2) and imported into an energy simulation and life cycle cost assessment tool called IES.

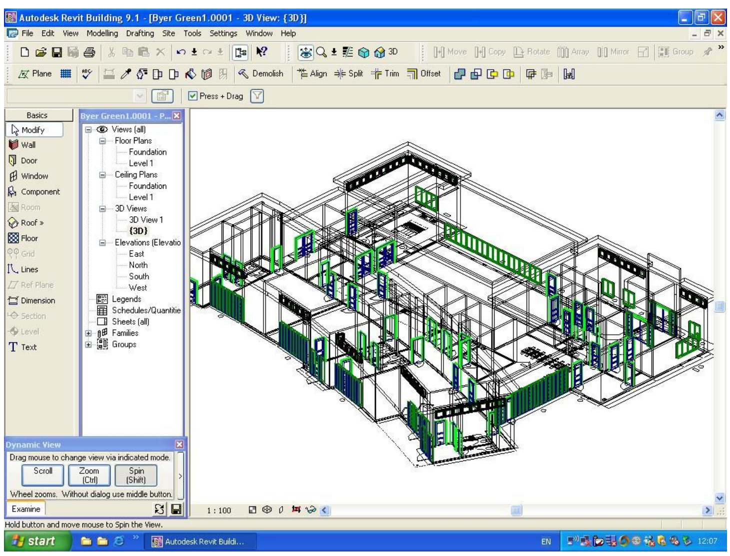


Figure 2: BIM model

The results from the IES tool including energy consumption, CO2 emission, and life cycle cost of building were input into the EATT tool developed within MsExcel.

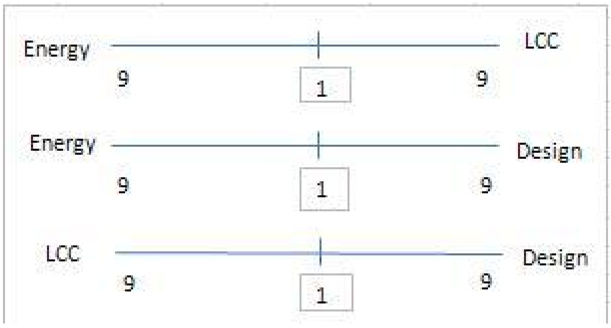
Below is a simple example to demonstrate the AHP trade-off process and figures might not be accurate.

3.1 **STEP 1 - Generate global weighting**

To complete the global weighting process, the decision maker will first refers to the criteria weighting ratio (figure 3). If the criteria at the right are more important, then the assigned value should be 1 to 9, else, if the left criteria are more important then the assigned value is 1/2 to 1/9.

Follow by assigns the priority in numerical value into the yellow box (figure 4). As shown in the figure below, building energy efficiency is slightly more important than the life cycle cost and building design, whilst the design of building is slightly more important than life cycle cost. The logic can interpreted as:

Life cycle cost < Building design < Building energy efficiency



Energy= building energy efficiency

LCC= life cycle cost

Design= building design

Figure 3: Criteria weighting ratio

OVERALL WEIGHT		Energy	LCC	Design	priority vactor
Energy		1	2	3	51.235
LCC		1/2	1	1/4	15.8136
Design		1/3	4	1	32.9514
	sum	1.83333	7	4.25	100

Figure 4: Weighting Global Criteria

The global weighting value was calculated and building energy efficiency appears to have the highest priority (51.2%), followed by building design (33%) and life cycle cost (15.8%). These numerical representations give a clearer priority value to the decision maker. These priority vectors will be used in step 2.

To apply this approach in the reality, decision makers will prepare a performance matrix that consists of criteria with tangible value (ie. Construction cost, materials' rating) and intangible value (ie. Building design, area functionality). Cost-benefit analysis will be carried out using tangible data so that decision makers can make an absolute comparison and weight them according to the result, while weighting process for intangible value is based on decision maker's subjective perception. In other word, this tool can support both objective and subjective decision.

3.2 STEP 2 - Selecting the best alternatives

The next step is to assign a priority for each model based on the three criteria; this process is similar to step 1. The priority vector of step 2 will be added to the global weight and the model with highest value is the best options.

Model 1 is the model with combinations that achieve most of the set criteria (Figure 5). This model will then be referred to the Key Performance Indicators to ensure that the quality of the simulation model reaches/exceeds the standard.

Energy FACTOR		M1	M2	M3	priority vactor
M1		1	4	8	73.1313
M2		1/4	1	1	14.9495
M3		1/8	1	1	11.9192
	sum	1.375	6	10	100

LCC FACTOR		M1	M2	M3	priority vactor
M1		1	1	2	37.672
M2		1	1	4	47.1958
M3		1/2	1/4	1	15.1323
	sum	2.5	2.25	7	100

Design FACTOR		M1	M2	M3	priority vactor
M1		1	0.33333	5	28.2839
M2		3	1	7	64.3389
M3		1/5	1/7	1	7.37721
	sum	4.2	1.47619	13	100

M1	5274.61
M2	3632.33
M3	1093.07

Figure 5: Decision making for best Model combination

4 Summary

The lack of guidelines to judge the monitoring information for data input, difficulties in taking both qualitative and quantitative views of all stakeholders and lack of experience have been the major challenges in the decision making process. MCDA with trade-off functionality may provide a solution to these issues. This approach was selected for the research because of its capability in dealing with objective and subjective decision making processes, as well as its successful track record of implementation in various sectors. Out of many methods available in MCDA, Analytical Hierarchy Process (AHP) based on priority theory was selected as the most appropriate method for this research.

The conceptual idea of the AHP trade-off algorithm has been reported in this paper and the next step in the research will be to validate the prototype based on the criteria that proposed in the RIBA sub-process (Loh et al 2009) and to test the visualisation capability of 3D-EATT via a Building Information Modelling (BIM) server.

5 References

Basson, L., and Petrie, J.G., 2007. An integrated approach for the consideration of uncertainty in decision making supported by Life Cycle Assessment, Environmental Modelling & Software 22, p.167-176

Buchanan J T, (1994) An experimental evaluation of interactive MCDM methods and the decision making process, Journal of Operation Research Society 45, p1050-1059

Chen, S.J., Hwang, C.L. (1991). Fuzzy Multiple Attribute Decision Making: Methods and Applications, In: Triantaphyllou, E (ed), "Multi-criteria decision making method: a comparative study", Netherland: Kluwer Academic Publishers.

Fulop, J. (2004). Introduction to decision making methods, paper proceeding for workshop on Biodiversity & Ecosystem Informatics, the evergreen state collage, Dec 13-15, 2004.

HO, W. (2008) Integrated analytic hierarchy process and its applications - A literature review. European Journal of Operational Research 186, p.211-228.

Hobbs B F, Meier P M, (1994) Multicriteria methods for resource planning: an experimental comparison, IEEE Transactions on Power Systems 9, 1811-1817

Hobbs, B.F., Meier, P. (2000). Energy decisions and the environment: a guide to use of Multicriteria methods, Kluwer Academic Publishes, USA.

Klastorin, T., 2004. Project Management tools and trade-offs, Chapter 1, John Wiley & Sons Inc, p.13-14.

LINKOV, I., SATTERSTROM, F. K., KIKER, G., BATCHELOR, C., BRIDGES, T. & FERGUSON, E. (2006a) From comparative risk assessment to multi-criteria decision analysis and adaptive management: Recent developments and applications. Environment International, 32, 1072-1093.

Loh, E., Dawood, N, Dean, J. (2008a). Development of framework for the 3D-Environmental Assessment Trade-off Tool (3D-EATT), paper proceeding for 8th International Conference on Construction Applications of Virtual Reality (CONVR 2008), 21-22 Oct, Kuala Lumpur, Malaysia.

Loh, E; Dawood, N; Dean, J; (2007). Integration of 3D tool with environmental impact assessment (3D EIA), paper proceeding for 3rd ASCAAD 2007 international conference, 28-30 Nov, Bibliotheca Alexandrina, Alexandria, Egypt.

Loh, E; Dawood, N; Dean, J (2008b). Evolution from CAD to BIM – A case study with 3D-EATT, paper proceeding for ARCOM/Construct IT workshop, 14th March, University of Salford, Manchester, UK.

Loh, E.; Dawood, N., Dean, J. (2009). Development of RIBA sub-process to assist reduction of building life cycle impact: Integration of RIBA workstage with EU EIA

Legislation and ISO14040, paper to be published for Building Simulation 2009, 27th-30th July, University of Strathclyde, Glasgow, UK.

Mysiak, J. (2006) Consistency of the results of different MCA methods: a critical review. Environment and Planning C: Government and Policy, volume 24, pages 257- 277

Olson D L, Moshkovich H M, Schellenberger R, Mechitov A I, (1995) Consistency and accuracy in decision aid: experiments with four multiattribute systems, Decision Science 26, 723-748

Refsgaard, J.C., Van Der Sluijs, J.P., Hojberg, A.L., Vanrolleghem, P.A. (2007) Uncertainty in the environmental modelling process- A framework and guidance, Environmental Modelling & Software 22, 1543-1556

Saaty, T (1980). The Analytical Hierarchy Process, Mc Graw-Hill, New York.

Saaty, T.L (2001). How to make a decision. In: Saaty, T.L. and Vargas, L.G (ed.), "Models, methods, concepts and applications of the Analytical Hierarchy Process, USA: Kluwer Academic Publisher.

Salminen P, Hokkanen J, Lahdelma R, (1998) Comparing multicriteria methods in the context of environmental problems, European Journal of Operational Research 104, 485-496

Steuer, R.E. (1986). Multi criteria optimisation: theory, computation and application, New York:Wiley.

Tecle A, (1992) Selecting a multicriterion decision technique for watershed resources management, Water Resources Bulletin 28, 129-140

Triantaphyllou, E (2000). Multi Criteria Decision Making Methods: A comparative study, Kluwer Academic Publisher.

WONG, J. K. W. & LI, H. (2008) Application of the analytic hierarchy process (AHP) in multi-criteria analysis of the selection of intelligent building systems. Building and Environment, 43, 108-125.

Once upon a climate: arid urban utopia of passive cooling and the diversity of sustainable forms

Mohamad Fahmy, Prof. Stephen Sharples

University of Sheffield, UK

As sustainability is needed for built environment future, reducing communities' energy consumption and passive design are the only choices. Such approaches will also deliver improved urban thermal comfort for urban spaces. It has been argued that the complexities of urban climatology prevented the connection between climate knowledge and urban planning practice. Examples drawn for quarter neighbourhood design sets in Cairo were investigated using the numerical environmental modelling package (Envi-Met), explored the role urban passive planning can have in generating urban diversity as an important measure for urban sustainable forms. Urban form diversity can be presented in three factors. First, the degree of diversity, Dv; it is the ratio of whole site facades' areas to the whole urban site area. Second is urban context and third is housing typologies. A Degree of site compactness Dc, is the average urban site height multiplied by the urban constructed area. By increasing details of the clustered form used, simulations indicated a direct proportional relation between Dv and Dc. Maximum Dc of 2nd design set showed the highest Dv value of 2.25 and reported better comfort levels. But, this form height achieved by population limit of Egyptian urban planning law could be more than the allowed 1.5 aspect ratio value of street canyon. Consequently, the less Dv of 2nd design set was preferable. Results conducted that, whilst the detailed form is concluded by urban passive utopia search for cooling in hot regions, the comfort provision not only helps form thermal sustainability but also its urban diversity.

Keywords: Degree of compactness; Dc, medium population form, sustainable development, urban comfort, Degree of diversity; Dv

1 Introduction

1.1 An overview

Sustainable urban development had broadcasting and collective interdisciplinary thoughts through time. Main approaches started in the 1970s and 1980s by the UN to define the future strategies for resources as a moral and physical commitment towards next generations, (Brundtland 1989; Pezzoli 1997a, 1997b). From an urban resource point of view, sustainability is not a complicated improvement of the post modern urban design pure artistic aesthetics rather than a functional vision of the urban space design and place making myths, (Jabareen 2006; Moughtin 1992).

However, despite the preparation for the urban sustainable development age in the 1980s, (Hoballah 2006; Selim 2008; UNDP and INP 2005; Zeitoun 1993), till now the two lines of sustainable urban design model and the post revolution urban modernism based on the socialist central housing plans and the theoretical values of post modernism urbanism didn't meet in a hot country like Egypt, (Ali 2003; Dona 1999; Fahmi and Sutton 2008; Stewart et al. 2004; Sutton and Fahmi 2001). The urban planning product from those two lines could be a passive sustainable treatment for urban patterns and form that might solve three main issues; accommodating people in acceptable houses, maintaining acceptable comfort level regarding people's acclimatization, and diverse urban forms.

1.2 Thermal comfort and sustainability

Among sustainability aspects of the built environment, is to close to indoor-outdoor comfort levels which in turn reduce, urban heat island effect, energy consumptions and cope with the global climate change, (McEVOY 2007). This paper concerns about urban thermal comfort which is difficult to assess due to the transient conditions of open environment. Nevertheless, it can be defined as the thermal sensation of a group of people in a specific built environment, (de-Dear and Brager 1998; Givoni 1998; Nikolopoulou and Lykoudis 2006).

The lake in application of climate knowledge due to complex interdisciplinary and intersected fields decreased urban climate studies dedicated to applied urban planning, (Ali-Toudert 2005; Arnfield 2003; Eliasson 2000; Oke 1984, 2006). On another hand, the theoretical physiological comfort model cannot support alone an actual sensation, (Nikolopoulou et al. 2001), nor to provide specific aesthetical values within urban context unless it is combined into an urban planning and design comfort model, (Fahmy and Sharples 2008b).

1.3 Urban sustainable forms

Urban form has raised as a crucial built environment issue from the late 1980s within governmental policies, (Allmendinger and Thomas 1998), due its direct effects on habitat, ecosystems, endangered species, water quality through land consumption, and replacement of natural cover with impervious surfaces. Moreover, urban form affects, the whole built environment systems, (EPA 2005). It is well documented that the more compacted form prevents wind access, increases population density and decreases green cover. Vernacular architecture in metropolitan Cairo is an example. Oppositely, the open fabric form with reduced height to width street canyons, single family housing in dot patterns of Cairo's master plan developments for example, overwhelms fabric surfaces with excessive heat gains, (Taha 1997; Pearlmutter and Shaviv 2005; Johansson 2006). Consequently, a medium population with reduced surfaces gaining heat is needed.

It can be argued that medium population planning provided by linear clustered form is a key issue as clustered form stands in between the open and the compact form from a land use point of view, (Fahmy and Sharples 2009a; Marcus and Sarkissian 1986). The linear form can support privacy for enclosed urban spaces, continuity, (DTLR and CABE 2001). The clustered fabric with medium population density can perceive a successful passive design form, (Oke 1988), and good thermal performance, (Bourbia and Awbi 2004), provide cooling effects, (Shashua-Bar and Hoffman 2004), and better performance if its proportions have been adjusted, (Muhaisen 2006).

(Jabareen 2006) defined sustainable forms in terms of seven issues;

1. Compactness.
2. Sustainable transport, (and also accessibility to facilities).
3. Density.
4. Mixed land uses.
5. Diversity.
6. Passive solar design.
7. Greening.

The sustainable forms that can provide urban comfort have taken much concern of research in the field of urban climatology (Ali-Toudert and Mayer 2007b; Eliasson 2000; Golany 1996; Landsberg 1973; Oke 1984, 2006; Swaid 1992). There was a utopia concerning what is the form that can perform well in each climate and what is the link between climate knowledge and urban planning. The rural and suburban patterns of a city are mostly open patterns whilst centre and core areas are more compact, (Duany 2002; Oke 2006). So, if medium population clustered patterns could control the form not to be a very compact to prevent wind access nor to be too open to provide solar shading, (Fahmy and Sharples 2008c), a question appear; is it an obligation to have fixed forms to achieve comfort? Does comfort based neighbourhood planning deliver a diversity of sustainable urban forms as an application for climate knowledge parallel with reducing thermal sensation and save energy?

2 Methodology

As a need to accommodate, a specific degree of compactness arises. Degree of compactness *D*c, as a link between climate knowledge and urban planning practice, is the average urban site height multiplied by the urban constructed area, (Fahmy and Sharples 2009a). Based on the experience gained from the new urban town developments of Greater Cairo, an assessment of quarter neighbourhood theoretical design, indicated how linear clustered pattern form, as medium population housing can thermally perform better. Two design sets were used applying basic neighbourhood planning concepts with parallel shaded and irradiated canyons. The first design set has two *D*c, but the second set has three to reach the population limit of law3, (Law3 1982), as it is the more detailed form after (Ali-Toudert and Mayer 2007b), and can provide more closure to comfort as a bigger scale of traditional courtyard. Simulations were held for three orientations 15°, 45° and 75°. The numerical simulation software, ENVI-met, (Bruse 2008), was used for assessing the comfort levels.

As thermal comfort is an important sustainability measure, urban diversity is another important measure. Increasing the compactness degrees by accommodating more population which in turn increases average canopy layer height (average site height) can reveal in better performance as the more detailed clusters were used. The shadows generated from these details and the increased canopy height decreases the total heat budget of urban canyons and spaces.

To assess the urban form degree of diversity three factors can be presented; first is the ratio of whole site facades' surface areas including openings to the whole site area. It stands for the diversity of pedestrian visual perspectives due to the differentiated skylines and facades. Quantitatively, the more fabric facades' surfaces, the more degree of diversity. Moreover, increasing number of cluster fragments offer more walking tendency in an intensely various closes with pedestrian approaches, urban places and scenes, (DTLR and CABE 2001; Jacobe 1961).

Second factor is the urban context. A simple master plan graphical analysis for urban private-public spaces has been performed to assess urban spaces. For simplicity reasons, the zoning and focal points for all of them are the same based on pedestrian linkage axial concept over a grid pattern in order to restrict urban diversity only to the *D*v factor. All cluster forms of the design sets imported 3-4 distinct fabric forms, 3 different shapes of urban places in addition to the green avenues and the civic centre of the quarter neighbourhood. Eventually, an adhesive urban habitat would be established.

(Day 2003) argued for more housing typologies to account for urban diversity which considered as the third indicator in this work, but it hasn't been counted to affect the diversity for any design set to base the work only on clusters details effects. However, all of sets are based on a 150 Sq.m. unit/family that can be horizontally or vertically doubled to increase housing unit area and generate diversity of housing types.

To study how can urban diversity affected by passive design, human thermal comfort perception at 30° 7'N and 31° 23'E for 9 selected points 1.2m above ground level was assessed using the predicted mean vote scale *PMV*, (Heidari and Sharples 2002; Humphreys and Nicol 2002; Jendritzky and Nübler 1981; Olesen and Parsons 2002). The 26th of June, the extreme hot day of Cairo's summer, (ASHRAE 2005), was simulated for 6h from 11.00-16.00 LST to investigate the extreme comfort levels.

3 Results;

Table no.1 illustrates the planning indicators for the 9 points for 3 orientations of the 5 design sets. Fig.1/a, b, c is mapping of all sets' sheltering behaviour against direct solar radiation illustrated over each set master plan 1.2m above ground level when solar altitude is 83.3° at 13.00 LST. The less grey area, the less solar access whereas up on the scale means the reduce amount of W/m2 gained at this level.

All maximum *PMV* values are either at 12.00 or 13.00 LST due to the solar altitude direct gain. All minimums reported in the cluster courtyards wings at 16.00 LST. Among Set1, the minimum *PMV* values recorded for a pattern orientation was 3.21 for Set1_Dv1_45° at which *D*v is 0.50 which is the minimum *D*v recorded. By increasing *D*c from 0.84 to about 1.04, *D*v increased to 0.65 at which the minimum *PMV* inside clusters stayed around the 45° orientation.

In Set2, the *D*c stayed 1.04 but design details tremendously doubled *D*v to 1.27. This moved the minimum recorded *PMV* value to be 3.07 at Set2_Dv1_15° then to 2.73 at Set2_Dv2_75° of *D*v 1.62 due to increasing *D*c to 1.30.

The minimum *PMV* was 1.90 at 16.00 LST of Set2_Dv3_75° which has the maximum *D*c of 1.549, *D*v of 2.25. Urban form design details increase the urban diversity quantitative factor *Dv* as described. Comparison between the compactness and diversity degrees against *PMV* is shown in fig.2. Table no.1 also shows a direct proportional relation between *D*v and *D*c for all design sets.

Table (1): Housing and sets' urban planning parameters;

	Design set name	Site area in feddans	% of Green coverage area	% Urban construction	Average no. of site floors	Compactness degree, *Dc*	Diversity degree, *Dv*	person/feddan	Law no.3
1	Set1_Dv1	51.07	0.25	21.8	3.88	0.84	0.50	82.2	100 -150 p/fed
2	Set1_Dv2	51.07		21.8	4.75	1.04	0.65	103.4	
3	Set2_Dv1	37.24	0.18	26.5	3.92	1.04	1.27	115.2	
4	Set2_Dv2	37.24		26.5	4.92	1.30	1.62	124.5	
5	Set2_Dv3	37.24		28.0	5.85	1.55	2.25	143.4	

- Facilities buildings at service civic centre are 10m height in all design sets and 13 m in Set2_Dc2, 3 to increase facilities.
- The actual residential land use can be calculated after extracting 33% for the network and green coverage as (Law3) tells, also after extracting the civic buildings plot areas, hence the residential land use for example for Set2_Dc3 is 23.707 feddans is 63.66% of site area, i.e. the actual constructed area which is 10.428 feddans gives construction percentage of 43.99 %.
- Feddan = 4200 sq.m.

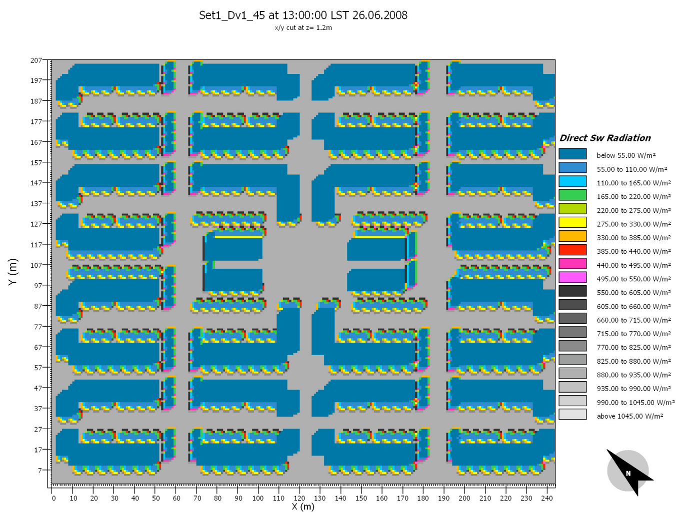


Fig. 1/a. direct radiation of Set1_Dv1_45° at 13.00 LST, 1.2m a.g.l.

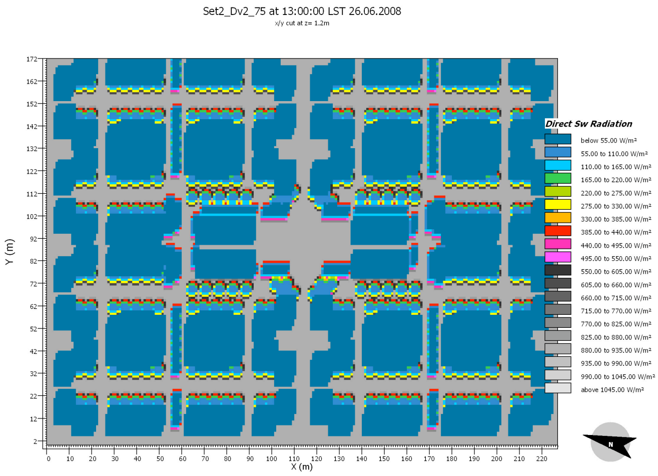


Fig. 1/b. direct radiation of Set2_Dv2_75° at 13.00 LST, 1.2m a.g.l.

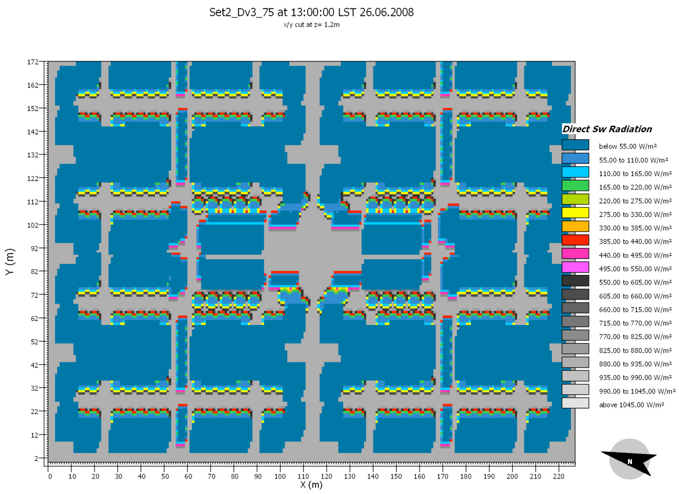


Fig. 1/c. direct radiation of Set2_Dv3_75° at 13.00 LST, 1.2m a.g.l.

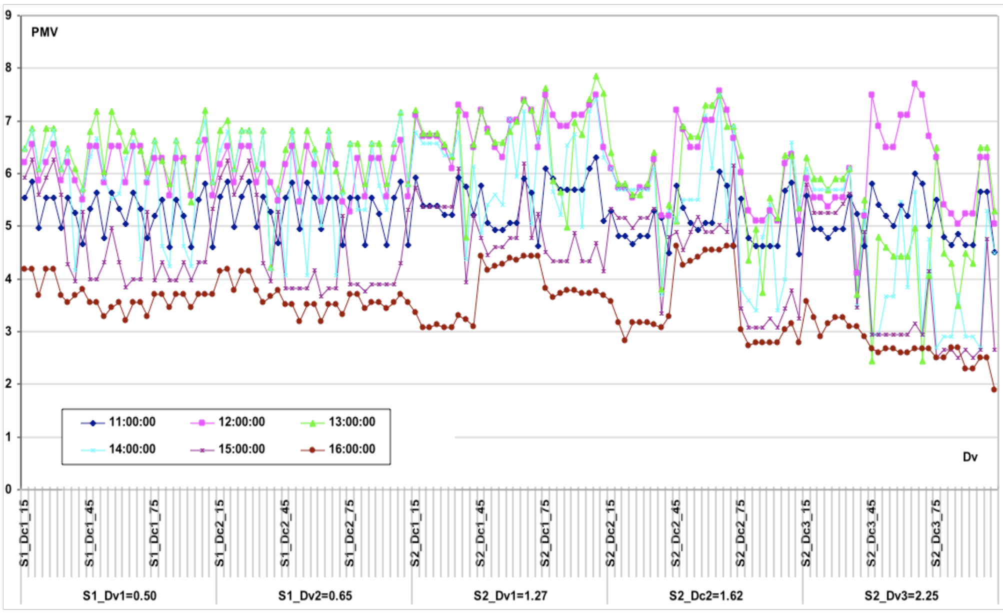


Fig.2: Plotting of PMV against Dv, for the 9 points in each orientation of each set.

4 Discussion: Comfort and degree of diversity

One can think that medium population clusters are blocks just like the international style of the mid last century, this paper is not revisiting the socialist urban planning rather than a search for thermal comfort sustainable forms. The utopia of comfortable communities especially in hot regions tends to condense the fabric but caution should take place to both sheltering from wind as well as radiation.

In other words, as sustainable form measure diversity, the fear was that the climate based form converts to blocks and loose points on the sustainable from measure of diversity. The usage of past residential blocks came as a need to accommodate without any concern about urban thermal behaviour; examples can be drowned from many places, (Ladd 2001; Tsenkova 2004).

Herein this paper, results show that while Set2 performed better comfort levels inside and outside urban clusters used. Its clusters details that helped improving comfort levels also kept urban scenes, skylines and surfaces at diverse levels in terms of increased whole site facades areas. Facades' areas represent more or less varieties of pedestrian visual perspectives. This didn't contribute to more heat gain from direct radiation due to the orientation and the compactness of the form.

Set2_Dv3 showed a value of 2.25 which means more than double of the urban site area and reported the better comfort levels. But, no. of average floors achieved to reach the population limit of Egyptian urban planning law and increase *Dc* is more than law106, (Law106 1999), states for some street canyon aspect ratios in Set2. Consequently, Set2_Dv2_75° of 1.62 is the preferable degree of diversity regardless the higher PMV value which can be decreased by other passive techniques out of the scope of this paper.

5 Conclusion

Investigated in this paper, how urban form can keep urban diversity as an important measure for sustainability at local urban planning scale. Simulations were performed to assess a quarter neighbourhood comfort based design effects on providing diversity. Urban form diversity can be presented in three factors; the degree of diversity, urban context and housing typologies. The latter two factors have been fixed in order to study the effect of the first one, the degree of diversity, *D*v. The degree of diversity can be defined as the ratio of all form facades' areas to the total area of urban site and it is directly proportional with the degree of compactness. Results conducted that, whilst the detailed form is a response of urban passive utopia search for cooling in hot regions, comfort provision not only helps thermal sustainability but also urban diversity.

6 References

Ali-Toudert, F. (2005). *Dependence of Out Door Thermal Comfort on the Street Design in Hot and Dry Climate.* Institute of Meteorology, PhD. Thesis, Freiburg, Germany.

Ali-Toudert, F andMayer, H. (2007b). Effects of asymmetry, galleries, overhanging fac¸ades and vegetation on thermal comfort in urban street canyons. *Solar Energy, 81*(6), 742–754.

Ali, E A. (2003). Evaluation of the Egyptian Experiment in Establishment the new Towns in the Desert Areas. *Journal of Engineering Sciences, Assiut University of Egypt, 31*(1).

Allmendinger, P andThomas, H (Eds.). (1998). *Urban Planning and the new British Right.* London: Routledge.

Arnfield, A J. (2003). Two Decades of Urban Climate Research: A review of Turbulence, Exchange of Energy , Water and the urban heat islands. *International Journal of Climatology, 23*(1), 1-26.

ASHRAE. (2005). *ASHRAE Hand Book of Fundamentals (SI Edition).* Atlanta: American Society of Heating, refrigerating, and Air-Conditioning Engineers Inc.

Bourbia, F andAwbi, H B. (2004). Building cluster and shading in urban canyon for hot dry climate Part 2: Shading simulations *Renewable Energy, 29*(2), 291-301

Brundtland, G H. (1989). Global change and our common future. *Environment 31*(5), 16-20, 40-42.

Bruse, M. (2008). *ENVI-met V3.1BETA, a microscale urban climate model, [Online], Available: www.envi-met.com. Accessed 18/2/2009.*

Day, K. (2003). New Urbanism and the Challenges of Designing for Diversity. *Journal of Planning Education and Research, 23*(1), 83-95.

de-Dear, R J andBrager, G S. (1998). Developing an Adaptive Model of Thermal Comfort and Preference. *ASHRAE Transactions 104* (part no.1a), 145-167.

Dona, J S. (1999). Changing Cairo: the political economy of urban form. *International Journal of Urban and Regional Research, 23*(1), 103-127.

DTLR andCABE. (2001). Better Places to Live by Design: A Companion to PPG3. London: UK Department of Transport, Local Government and the Regions and Commision for Architecture and the Built Environment.

Duany, A. (2002). Introduction to the Special Issue: The Transect. *Journal of Urban Design, 7*(3), 251–260.

Eliasson, I. (2000). The use of climate knowledge in urban planning. *Landscape and urban planning 48*(1-2), 31-44.

EPA. (2005). Cool Pavements Study - Task 5 for Heat Island Reduction Initiative. *US Environmental Protection Agency, Cool Pavement Report*

Fahmi, W andSutton, K. (2008). Greater Cairo's housing crisis: Contested spaces from inner city areas to new communities. *Cities, 25*(5), 277-297.

Fahmy, M andSharples, S. (2008b). The need for an urban climatology applied design model, *The online newsletter of the International Assocciation for Urban Climatology* (Vol. 2008(28), pp. 15-16): IAUC.

Fahmy, M andSharples, S. (2008c). Passive design for urban thermal comfort: a comparison between different urban forms in Cairo, Egypt, *PLEA 2008 - 25th Conference on Passive and Low Energy Architecture*. University Collage of Dublin, Dublin, 22nd to 24th October 2008. Dublin, UK, October 22-24.

Fahmy, M andSharples, S. (2009a). On the development of an urban passive thermal comfort system in Cairo, Egypt. *Building and Environment, In Press, Corrected Proof, DOI; 10.1016/j.buildenv.2009.01.010*.

Givoni, B. (1998). *Climate consideration in urban and building design*. New York: Van Nostrand Reinhold.

Golany, G. (1996). Urban design morphology and Thermal performance. *Atmospheric Environment, 30*(3), 455-465.

Heidari, S andSharples, S. (2002). A comparative analysis of short-term and long-term thermal comfort surveys in Iran. *Energy and Buildings, 34*(6), 607-614.

Hoballah, A. (2006). Sustainable development in the Mediterranean region. *Natural Resources Forum, 30*(2), 157-167.

Humphreys, M A andNicol, J F. (2002). The validity of ISO-PMV for predicting comfort votes in everyday thermal environments. *Energy and Buildings, 34*(6), 667-684.

Jabareen, R. (2006). Sustainable Urban Forms: Their Typologies, Models, and Concepts. *Journal of Planning Education and Research, 26*(1), 38-52.

Jacobe, J. (1961). *The Death and Life of Great American Cities*. New York: Random House.

Jendritzky, G andNübler, W. (1981). A model analysing the urban thermal environment in physiologically significant terms. *Meteorology and Atmospheric Physics, 29*(4), 313-326.

Ladd, B. (2001). Socialist Planning and the rediscovery in the old city in the German Democratic Republic. *Journal of urban history, 27*(5), 584-603.

Landsberg, H. (1973). The Meteorologically Utopian City. *Bulletin of the American Meteorological Society, 54*(2), 86-89.

Law3. (1982). Urban planning law and excutive regulations. Cairo: Egyptian Ministry of Urban Planning and Housing.

Law106. (1999). Regulating Construction Work amendments within Low no.101 1996. Cairo: Egyptian Ministry of Urban Planning and Housing.

Marcus, C C andSarkissian, W. (1986). *Housing as if People Mattered: Site Design Guidelines for Medium Density Family Housing*. Los Angeles University of California Press.

McEVOY, D. (2007). Climate Change and Cities. *Built Environment, 33*(1), 5-9.

Moughtin, C. (1992). *Urban Design: Street and Square*. Oxford: Butterworth Architecture.

Muhaisen, A S. (2006). Shading simulation of the courtyard form in different climatic regions *Building and Environment, 41*(12), 1731-1741

Nikolopoulou, M, et al. (2001). Thermal comfort in outdoor urban spaces: Understanding the Human parameter. *Solar energy in the urban environment, 70*(3), 227-235.

Nikolopoulou, M andLykoudis, S. (2006). Thermal comfort in outdoor urban spaces: Analysis across different European countries. *Building and Environment, 41*(11), 1455–1470.

Oke, T R. (1984). Towards a prescription for the greater use of climatic principles in settlement planning. *Energy and Buildings, 7*(1), 1-10.

Oke, T R. (1988). Street Design and Urban Canopy Layer Climate. *Energy and Buildings, 11*(1-3), 103-113.

Oke, T R. (2006). Towards better scientific communication in urban climate. *Theoretical and Applied Climatology, 84*(1-3), 179-190.

Olesen, B W andParsons, K C. (2002). Introduction to thermal comfort standards and to the proposed new version of EN ISO 7730. *Energy and Buildings, 34*, 537-548.

Pezzoli, K. (1997a). Sustainable Development: A Transdisciplinary Overview of the Literature. *Journal of Environmental Planning and Management, 40*(5), 549 - 574.

Pezzoli, K. (1997b). Sustainable Development Literature: A TransdisciplinaryBibliography. *Journal of Environmental Planning and Management, 40*(5), 575 - 602.

Selim, T H. (2008). *Comparative Human Development: Egypt, Middle East, and the Developing World*. Cairo: SSRN.

Shashua-Bar, L andHoffman, M E. (2004). Quantitative evaluation of passive cooling of the UCL microclimate in hot regions in summer, case study: urban streets and courtyards with trees. *Building and Environment 39*(9), 1087 - 1099.

Stewart, D J, et al. (2004). Assessing the Spatial Structure of Urban and Population Growth in the Greater Cairo Area, Egypt: A GIS and Imagery Analysis Approach. *Urban Stud, 41*(1), 95-116.

Sutton, K andFahmi, W. (2001). Cairo's urban growth and strategic master plans in the light of Egypt's 1996 population census results. *Cities, 18*(3), 135-149.

Swaid, H. (1992). Intelligent Urban Forms (IUF) A New Climate-Concerned, Urban Planning Strategy. *Theoretical And Applied Climatology, 46*(2-3), 179-191.

Tsenkova, S. (2004). Managing Change in post communist Cities. *conference of; Winds of Societal Change: Remaking Post-Communist Cities, University of Illinois, 18-19 June*

UNDP andINP. (2005). *Egypt Human Development Report.* Cairo: Institute of National Planning, Egypt and the United Nations Development Programme.

Zeitoun, S. (1993). *The 20th century Architecture*. Cairo Alahram Commercials.

Slum rehabilitation in the context of urban sustainability: a case study of Mumbai, India

Amey Sheth, Prof Andrew Price, Nagendra Velega

Loughborough University, UK

In the last two decades, migration from villages and small towns to metropolitan areas has increased tremendously in India. This leads to the degradation of urban environmental quality and sustainable development especially in the metropolitan cities. The problems faced by the people living in the urban areas of India have become major concerns for the government over the last two decades. Slums are considered to be the major issue within many urban areas; particularly problems related to transportation, population, health and safety. India is one of the fastest developing countries with many metropolitan cities (e.g. Mumbai, Pune, Bangalore, Hyderabad, Delhi and Chennai). To explore the effect of rehabilitation of slums on urban sustainability, part of Mumbai was selected as a case study. Compared to the other metropolitan cities in India, Mumbai is one of the biggest metropolitan regions and capital of the state of Maharashtra with many slums varying in sizes. In addition, every year millions of rupees are being spent to resettle and rehabilitate slums to make Mumbai sustainable. It is reported that around 6 percent of the total land holds nearly 60 percent of the total Mumbai population (CBC, 2006). From 1980 onwards, the rate of migration and the sprawling nature of slums into the city has become an major issue, although many organisations are working towards development of Mumbai, the conditions are not conducive to achieving urban sustainable environment as most of the organisations are not working on a united front. Also, various researchers have reported that to maintain the pace of sustainable urbanisation, a holistic approach to sustainable development needs to be considered.

Considering today's poor urban environmental quality in Mumbai, there are many projects under development and execution to improve the poor conditions. Also, the World Bank has funded many projects with the primary aim of improving the city's land transport, health and education which affect thousands of families. The majority of families affected by urban development projects are located in slum areas which are under consideration for resettlement and/ or rehabilitation. The aim of this research is to examine slum areas and their effects on sustainable urban development. To accomplish the above aim, a case study based approach, engaging a series of face-to-face interviews, was used. As a part of this research, an urban development project funded by the World Bank to achieve urban sustainability in Mumbai Metropolitan Region (MMR) was explored. Also, several visits to other slums and rehabilitated areas were conducted to identify the quality of life in slums and rehabilitated areas. The data collected during the face-to-face interviews, was used for descriptive analysis considering various aspects (i.e. social, educational) of urban sustainability. Through this research, the reasons for slums and problems related to slums were explored. During the research, it is revealed that some people still think that urbanisation is responsible for unsustainable development and they are not in favour of resettlement and rehabilitation. This suggests that to achieve successful urban sustainability, other issues such as employment, education and general awareness are also required along with low-cost mass housing.

Keywords: slums, rehabilitation and resettlement, sustainable development

1 Introduction

Slums are often defined as, *"buildings and areas that are environmentally and structurally deficient. A result of multiple deprivations such as; illegal land tenure, deficient environment and inadequate shelter and are the result of the gap between the demand and the legal and formal supply in the housing market" (Chauhan, 1996).* Mumbai, formerly known as Bombay, India's financial capital, attracts people from all over the country. The United Nations (UN) reported that Mumbai is the seventh largest city in the world, has the fifth fastest rate of population growth and is the sixth most populous city in the world (O'Hare et al., 1998). But, behind Mumbai's glitz, glamour and attraction there are different realities; the city landscape is dominated by massive, sprawling slums. In Mumbai some of the slums are the biggest in the world (Jha, 2008) and their origin can be seen from the late 17th century (Dalvi, 1997). The outcome of consumer expenditure data survey, conducted by National Sample Survey (NSS) of India, reveals that 15 percent of the total urban population of the country are living in slums (Dhingra et al., 2008). Alex, 2005 reported that, eight million out of the twelve million people in Mumbai are living in slums; and one in every three people in the world could be living in slums by 2030. Mumbai is not alone; slums are global problems, accommodating a billion people (Alex, 2005).

In the Mumbai Metropolitan Region (MMR) various organisations are working towards upgrading slums in order to improve the urban environmental quality of Mumbai. Some examples are: MMR-Development Authority (MMRDA) and City and Industrial Development Corporation (CIDCO), which are regional planning authorities; the Maharashtra Industrial Development Corporation (MIDC) a planning entity for the industrial estate developed under the control of state government. In addition to these, Slum Rehabilitation Authority (SRA), Slum Rehabilitation Society (SRS), Maharashtra Housing and Area Development Authority (MHADA), Brihanmumbai Municipal Corporation (BMC), etc. are also working towards the improvement of slums in Mumbai. In 2006, it was reported that there are more than 60 registered non-governmental organisations (NGO's) working towards the development of Mumbai slums to make it a good habitable place (Karmayog, 2006). Also, the long-term vision of SRA is, "to make Mumbai slum-free by the year 2015" (Dutt, 2004). Most of these organisations are funded by various sources such as World Bank, central government, state government, and corporations. Recently, World Bank has invested 32000 million in Indian National Rupee (INR) to improve the urban environmental quality of Mumbai. This is the largest urban resettlement project ever undertaken in India (Dutt, 2004). Other than World Bank several organisations have already invested millions and billions (INR 5000 million in 2003 and INR 160 billion in 2008 by local government) of rupees towards the development of Mumbai slums. The local municipal authority reported that every year a billion rupees are spent before monsoon season preparing for the rains (Allen, 2008).

As mentioned in literature, a significant amount of money is already invested and is set aside to be invested in the future (Pandey, 2007); however, Mumbai still seems to be far away from a sustainable urban development. There are many key problems such as slums, population and unregulated growth in the way of sustainable urban development. These problems are discussed in this paper. One of the key reasons for Mumbai being far from sustainable urban development is that most of the above mentioned and presently active organisations (governmental and non-governmental) are working individually with a lack of proper central control and coordination. Inadequate initiatives and improper procedures taken at this stage will augment the future impact of slums on urbanisation making them impossible to ignore. Through this research, key issues and priority areas which need to be addressed are highlighted and discussed with the help of a literature review and a case study. To conduct the case study, one of the five major link roads under development in the MMR was selected. The details about the case study and project are explained in Section 4.

The paper is divided into six sections: the aim, objectives and methodology of this research are discussed in Section 2. The literature review and case study are discussed in Sections 3 and 4 respectively. In order to support the literature review several interviews were conducted; this is discussed in Section 5. The research work is summarised and concluded in Section 6. This is followed by references and acknowledgments.

2 Study aim, objectives and methodology

The primary aim of this research is to explore slums to understand their impact on sustainable urban development. To achieve the above aim the following objectives were formulated.

1. To explore existing slums and understand how slum rehabilitation and resettlement projects work.

2. To explore one of the major projects at the execution stage involving rehabilitation to achieve sustainability in Mumbai.

3. To understand the attitude of slum dwellers towards urban sustainability.

4. To examine why rehabilitation and resettlement projects are not achieving considerable success.

5. To understand the gap between families shifting from slums to rehabilitated buildings.

To achieve the above objectives, a case study based methodology, which involved face-to-face interviews and literature review were employed. The main purpose of conducting a case study was to know the ground realities related to the project; slums and urban sustainability. Also, to accomplish the aim and objectives of this study, several visits and observation were made to slums located in different pockets of the MMR. As discussed before, Mumbai was selected as it is one of the biggest metropolitan regions in the world, which has many large scale slums (Nijman, 2008).

In Mumbai there are 'Eastern', and 'Western' express highways, which run parallel in a North-South direction along the length of the suburbs. Also, when the existing plan of the city is studied, one can see that there are very few road links connecting the East and West. Hence, several projects in Mumbai are under development and are at the execution stage related to roads connecting the city in the East-West direction. In this research, one of the five proposed major link roads connecting 'Eastern' and 'Western' express highways passing through part of an existing hutment in Mumbai was selected. This is discussed further in Section 5. The research was guided by a set of questions related to origin, history, impact, and future development related to slums. Several observations were made during a number of site visits to various slums. The collected data were used to analyse the slums and their impacts on the sustainable development of Mumbai which are presented at the end of the paper.

3 Literature review

As a part of the literature review, various aspects related to slums and urban sustainability were considered and explored. In this section, existing slums and their impacts in Mumbai and slum rehabilitation in the context of urban sustainability were reviewed. At the end of this section execution of slum rehabilitation projects are discussed.

3.1 Existing slums and there impacts in Mumbai

On looking at Mumbai from an aerial view, one can see many small and large scale black spots, so called slums and hutments sitting in the different pockets of the city. As mentioned before, while slum pockets cover a mere 6 percent of the land in Mumbai, they hold about 60 percent of the total population (CBC, 2006). All the slums in Mumbai are not merely residential, but have many commercial units such as, shops and small scale industries. However, in Mumbai a high rate of migration to the city from the rest of India resulted in the growth of slums. The development of low-cost housing could not accommodate all the migrants (Dalvi, 1997; Giridharadas, 2008). Slum growth started about a half century back. From the literature, some developments (for example, ports and harbours), which took place in the past are identified as a reason for increasing the slums. During such developments a group of people were displaced from certain locations without provision of alternative housing and other facilities, which resulted into the some of the existing slums today. In some studies it is found that the gap created by the supply of 17,600 housing against the need for 46,000 houses in the 1960s and the supply of 20,600 housing against the need for 60,000 housing in the 1970s also augmented the growth of slums (Shetty, 2007). At the same time, though several organisations are working, lots of efforts are made and investment spent to control the growth of slums; still sustainable urban development is far from a considerable level. It is reported that 55 percent of the total population is living in more than 2,500 slums located in different parts of Mumbai (O'Hare et al., 1998). About 50 percent of these slums are spread on private land, 25 percent on state government land, 20 percent on municipal land and the remaining 5 percent on Central government and housing board land (Dalvi, 1997). It is reported that there are 5 million slum dwellers, 1.2 million slum families eligible for rehabilitation in Mumbai; and "rehabilitating all of them will cost over INR 210,000 million,"(Iyer, 2005). The area wise slums population in the MMR is shown in Table 1. As population surveys are conducted every 10 years, the population in the year 2001 is presented.

A review of literature and observations made during visits to some slums reveals that unhygienic conditions and population density (overcrowded) are very common problems with all slums (Husock, 2009). Overcrowding within the slum neighbourhoods has impact on various facilities available in urban areas (such as public transport, water and sanitation) are responsible for an unpredicted extra load on the amenities in the city (Dhingra et al., 2008). Also, literature confirms that, it is difficult to mark exact boundaries of slums, density, and to allocate exact funds to improve their conditions. As growth of slums is uncontrolled, unregulated and unpredicted; it is very difficult to implement and execute any proposed development in and around the slums. The existing slums have considerable impacts on quality of life, development and sustainability of urban areas at micro and macro levels.

Table 1: Slum Population in Municipal Urban Area of MMR (2001)

(MMRDA, 2001)

Sr. No	Urban Area (Municipal Corporation /Councils)	Slum Population (in 000's)	Total Population (in 000's)	Percentage of slum population (%)
01	Greater Mumbai	5823.51	11914.40	48.88
02	Thane	420.27	1261.52	33.31
03	Kalyan-Dombivali	34.85	1193.27	2.92
04	Navi Mumbai	138.62	703.93	19.69
05	Bhiwandi	111.30	598.70	18.59
06	Mira Bhayander	37.24	520.30	7.16
07	Ulhasnagar	53.72	472.94	11.36

However, rehabilitations of slums put pressure on middle-class people resulting in paying more taxes to the governments (UN-Habitat, 2003). Moreover, the available and reserved money for the improvement of urban areas is utilized for development of existing slums which results in an overall undeveloped urban area. A study by Davis, in 2004, reported that, populations in the slums are often undercounted. Also, slums which exist on the maps; where a census has been done, exists a variation in population between the census and the actual population. In another study by Nijman, 2008, it is argued that, often, there is a variation in the actual boundary, location and population of the slums. Moreover, some slums in Mumbai do not exist on any maps, thus formal surveys and census have never been done with these slums (Nijman, 2008). Also, it was found that there was a significant difference in slum location and size population count in the actual census recorded by Greater Mumbai and in the field. The outcome of this above mentioned study reported that slums population and size are far more than the actual numbers mentioned in the census records.

3.2 Slum Rehabilitation in the context of urban sustainability

While understanding slum rehabilitation, the key reason for studying this is to understand; why slum rehabilitation is required? What is the relationship between slum rehabilitation and urban sustainability?

Urban sustainability is defined as "*Improving the quality of life in a city, including ecological, cultural, political, institutional, social and economic components without leaving a burden on the future generations" (Urban21, 2000).* Whereas, Sustainable Urban Development Association (SUDA) has define unsustainable urban development as "*often it is urban sprawl. Sprawl is low-density suburban development, usually consisting of subdivisions of detached and semi-detached, single-family houses, and scattered low-density commercial/industrial uses".*

In the long-term, unsustainable urban development can harm the health of urban dwellers (Huang et al., 1998). The first ever systematic effort to improve slums was made in the early 20th century, after consequences of the plague epidemics in the 1896. However, to rehabilitate crowded living areas and slums 'The City Improvement Trust' was formed on the 9th of December 1898 in

Mumbai (Dalvi, 1997). It is said that, presently Maharashtra is the only state in India to propose and carry out a massive slum rehabilitation programme. Also, the state government has come-up with an autonomous and a fully IT-based state-of-the-art “Slum Rehabilitation Authority” (SRA) to implement various schemes related to resettlement, rehabilitation and improvement of the slums in Mumbai. As mentioned earlier, large amounts of money have been invested and set aside by various organisations and governments (central, state and local) to achieve urban sustainability. Several projects initiated, funded or invested by the governments to improve the slums fall under the following categories, slums eradication and relocation, improvement, up-gradation and redevelopment and rehabilitation. From time-to-time the concerned government conduct several amendments in the regulations to improve slum conditions (SPARC, 2003; Mukherjee, 2008). But, it is reported that though there is incremental change in living conditions the slums are growing continuously.

3.3 How the slums rehabilitation projects work?

Slum Rehabilitation Society (SRS) is one of the oldest and active nongovernmental organisations (NGO) in Mumbai and working with a different approach to slum rehabilitation. Its strategy to improve slums is by promoting the "self-development" approach to prohibit the profiteering by an individual or organisation. The main beneficiaries of self development approach are both the occupants and the city. A slum rehabilitation scheme can be taken up on the plots that are notified, categorised and approved as a slum by the local government. If any of the plots covered by a slum is reserved for non-buildable reservation, then during the resettlement and rehabilitation the plot area should be more than 500 m^2 and minimum ground coverage should not exceed 25 percent by the slum rehabilitation. With self development approach, slum dwellers get an opportunity to appoint a developer for execution of proposal. Slum rehabilitation and self development in Mumbai is financed by ‘re-housing the slum dwellers’ in multi-storeyed buildings on one part of the land and selling the other part at commercial rates in the city. Also, 70 percent of the eligible slum dwellers from hutments can come together to form a society to implement the slum rehabilitation scheme. If the area is too dense and difficult to get a satisfactory sale component (as declared by local government), then the rights for developing the commercial area can be transferred to the northern suburbs under the scheme called Transferable Development Rights (TDR). The Floor Space Index (FSI) permissible for a scheme depends on the number of slum dwellers to be rehabilitated, but should not exceed 2.5. Also, after providing low cost housing, ex-slum dwellers living in an apartment receive help in the form of subsidies; tax reductions over a 20-year period and concession for an apartment maintenance. The tenement assigned to a slum dweller is for a minimum period of 10 years from the date of allotment and cannot be sold during that period.

Every slum structure existing on or before 1st January 1995 are eligible for rehabilitation and cheap housing. All the eligible residential slum structures are provided with an alternative tenement admeasuring 225 square feet preferably at the same side, irrespective of the area of their slum structure. However, tenements can be transferred to a legal beneficiary if approved by the Chief Executive Officer (CEO) of SRA. A onetime sum of INR 20,000 per tenement is recovered from the developer for subsidising the monthly maintenance of the building. Flats are allocated by an open lottery system and in rare cases family do get a chance to choose flats depending on individual circumstances (handicap, old age, etc).

4 About the case study

A Joegeshwari-Vikhroli Link Road (JVLR) is part of the Mumbai Urban Transport Project (MUTP) to improve traffic and transportation in the MMR (MMRDA, 2001). The Eastern and Western express highways connect the suburbs and Greater Mumbai. The JVLR, with length 10.8 km is one of the five major links proposed to connect the "Eastern" and "Western" express highways (Iyer, 2005). This project is funded by the World Bank. To implement this project it was estimated around 300 slums and 70 commercial units would be rehabilitated from slum areas (MMRDA, 2005). Pratap Nagar and Durga Nagar are situated at Jogeshvari in Mumbai on either sides of the JVLR as shown in Figure 1. However, the slums are situated in the Pratap Nagar; and rehabilitated buildings are situated in the Durga Nagar. During the case study, a plan for the resettlement was developed and was partly finished and partly under execution for the residential and commercial units. Considering the stage of the project, this particular area was selected for the case study. In Figure 1, a brief plan of Mumbai along with major roads and links are shown.

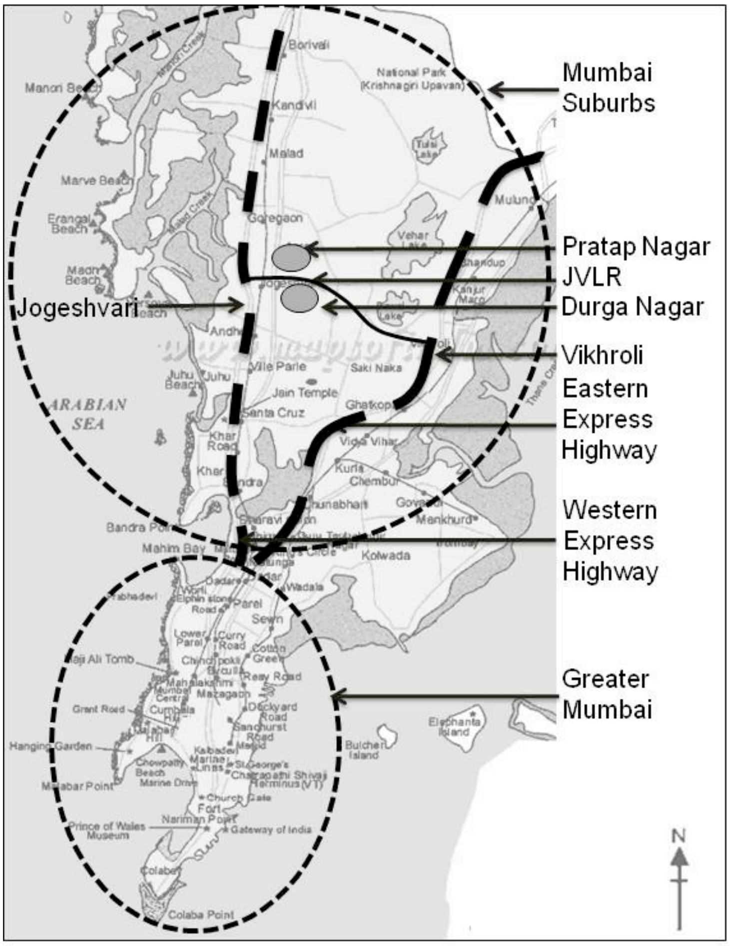


Figure 1: Schematic plan of the JVLR and Mumbai

Around 25 face-to-face interviews were conducted in 2006. Half of the interviews were conducted in the Pratap Nagar and rest in the Durga Nagar. The basic information collected during the interviews in both the areas was related to family profile including origin, amenities, space occupation, social life, monthly expenses and opinions related to the slums as well as rehabilitated areas. In the slum areas, the information collected during the interviews was only related to slums whereas in the rehabilitated buildings data was collected related to the rehabilitated buildings as well as slums.

The intention behind conducting this case study was to explore part of the ongoing project. The slums and their impact on the sustainable development were considered during the case study. The reason behind this resettlement is not just to relocate the people affected by the Mumbai Urban Transport Project (MUTP). The aim of this project was to rehabilitate an unlooked section of the society; slums, and take a step towards improving the quality of life in the urban environment. There are various issues involved in this process of rehabilitation. Based on our site visits and interviews in the Pratap and Durga Nagar the following issues are discussed, relevant to those particular areas.

4.1 Re-housing and Resettlement

During the case study it was observed that Pratap Nagar slums are not entirely affected by the project (JVLR). Different parts of Pratap Nagar which were getting affected because of the project were considered for rehabilitation and resettlement. As part of the research, the collected date was used for a descriptive analysis as presented in Sections 4.2 and 4.3. In Section 4.2 social and economical conditions are discussed in the slum and rehabilitated area, followed by environment and maintenance in Section 4.3.

4.2 Social and Economic Conditions

4.2.1 In slums:

1. The majority were Hindu families, much less Muslim families and a few catholic families who speak English were found in those particular areas.
2. The population is a mixed, one in terms of financial status.
3. High level of social interaction and social security is achieved due to the dense living conditions.
4. Complex and functional use of the small amount of space allocated for living and working (i.e. residential, commercial) in many cases.

4.2.2In rehabilitated areas:

1. As most of the flats are allocated on a lottery system, a mixed culture is observed.
2. Though population is mixed in terms of financial status, facilities and amenities are same for all.
3. High level of privacy, security and places for social interactions because of regulated growth.
4. Some level of segregation of areas (kitchen and living) within the flats and at the society level (commercial, residential and play areas).

4.3 Environment and Maintenance

The people living in the Pratap Nagar slums were very much concerned about the cleanliness. They not only take care of their individual dwellings but also of their neighbourhood up to some extent. It was observed that all the people living in the slums contribute some money monthly for the maintenance of their slum areas. We can see this difference at the border areas where garbage is thrown, which is never cleared. Drainage systems in the hutment areas are comparatively good. Wherever possible the inhabitants have tried to close the drains. We often found the drains on both sides of the streets. However, as the drainage and garbage is collected on the periphery of the hutments, overall quality of the slum areas are below an acceptable limit and unhealthy.

To maintain the hygiene in resettlement areas, SRA took initiative. They are trying to help groups of buildings by forming societies and choosing a concern person who will take care of issues related to buildings (such as cleaning, collecting and throwing away garbage). The SRA helps them to build a common area, where everybody can dump their garbage and it will be sent from there to a dumping ground and/ or for recycling.

4.4 Opinion about resettlement area

During the interviews, when asked about their personal opinion towards the resettlement schemes, the following positive and negative observations were obtained.

4.4.1 Positive feedback

1. People living in the resettlement area observed a significant increase in the amount of day light, ventilation and privacy; whereas most of these things are least in the slums.

2. Considerable increase in available number of facilities such as toilets, water, parking, school, public transport, roads, etc.

3. Resettlement provides more work opportunity and increase in monthly income.

4. Because of the regulated growth and upgradation in living standards they have good neighbourhood and friends.

5. The availability of the public bus services near the resettlement area reduces their travel time to work.

4.4.2 Negative feedback

1. Before the opening of the lottery to allocate their flats, they were not allowed to visit the flats.

2. Families, where only one person is earning, were scared to relocate, as this might increase their monthly expenses because of the additional facilities which are not there in the slums.

3. As every family will be getting 225 square feet each, irrespective of their slum areas in Pratap Nagar; those who are getting less than their previous area in slum were disappointed.

4. Many of them were reluctant to shift, because they will be moving to a 7-storey building (high rise) from the low rise slums.

5. Those who were supposed to shift their commercial units (shops) were unhappy as they might observe a drop in their business.

Also, other than the above mentioned reasons, it was found that public opinions regarding relocating themselves differed based on the following reasons.

4.4.3 Traditional v/s unorthodox

When compared, individuals, especially females, in orthodox families were not eager to move into a building, as one from a liberal family. This is because in orthodox families the women are confined to the houses and have a very limited social life. They feel that moving into a building will add to their isolation from the world. Hence, they were highly reluctant to move into apartments.

4.4.4 Financial security v/s poverty

From the interviews it was revealed that economically stable families had no problems moving into buildings compared to the economically unstable family. When asked, the economical reasons such as better lifestyle and regulated growth were given by the different part of the society.

4.4.5 Education v/s illiteracy

Observations made during the interviews revealed that people who are educated and more futuristic were keen to move. Education broadens their perspective and makes them want an apparently better lifestyle and environmental quality. On the other hand, people who are less educated and their life revolves around their small community prefer not to be isolated from their slum by moving. Also, we observed that some of the students, who are at school level, were keen on moving as there is provision of schools in the rehabilitated area, because they expecting good (educated) friends and better neighbourhood.

5 Descriptive analysis

To accomplish the aim and objectives, other than interviews in Pratap Nagar and Durga Nagar, several site visits were made to other slums located in different parts of Greater Mumbai and the suburbs. During the site visits to various slums in the MMR, certain observations were made related to hygiene, public transport, common facilities, etc as discussed in this section.

During this research a descriptive analysis was emphasized. For the success of rehabilitation and resettlement projects and sustainable urban development; individuals' criteria related to families are very important, are described with the help of descriptive analysis. This analysis related to rehabilitation project, general observation, land tenure pattern, hygiene, and transportation and emergency are as discussed in Sections 5.1 to 5.5. In section 5.1 the rehabilitation project is explored and general observation related to the same are given in Section 5.2. Land tenure was analysed to understand how slums are originated in an urban environment in Section 5.3. Whereas, Section 5.4 is about hygienic conditions to understand quality of life in the slums, and following Section 5.6 is about transportation and emergency to understand the importance of location for rehabilitation project.

5.1 Rehabilitation project

The reason behind resettlement and rehabilitation is an attempt to achieve the urban sustainability and efforts to respond to the requirements of the inhabitants. However, resettlement and rehabilitation could not achieve sustainability to a great extent as it is not considering all the aspects of sustainable urban development. As per the observations made during this research, the buildings constructed under the resettlement scheme are functional, well built and practical, but the socio-cultural aspects are not considered up to a great extent. Also, the closely clustered units and their scale generate an environment conducive for an active social life. More interaction is generated by the proximity and the multi functionality of the street and the space just in front of the houses. This further enhances the community/street life. There are provisions of office spaces for organizational committees to encourage people to participate in the process of rehabilitation and to make them more vigilant citizens. In the rehabilitated area there are wide streets provided for social activities to maintain the culture of an active street life but, often observed that they lack vegetations.

The people in the slums are more accustomed to having organized their spaces. They want multifaceted and multi-functional areas rather than having them defined and segregated areas as in apartments. Multifaceted and multi-functionality take an attachment to their homes on a higher level, to the spaces outside their houses and onto the streets. People do not participate personally in maintenance and hence do not have the same attachment to their outside spaces as they had formerly. This further isolates them from their surroundings. Some of the participants suggested that forming a board of members for the society may help to maintain cleanliness and hygienic conditions. However, this is a mundane aspect which is far away in making the project successful in the long run.

5.2 General observations related to slums in Mumbai

Following are the general observation made during the research. Slums do not have:

1. Basic municipal services such as water, sanitation, waste collection, storm drainage, street lighting, paved footpaths and roads for emergency access.
2. Sufficient play areas, schools and medical facilities for children.
3. Sufficient community places to socialise and to celebrate festivals.
4. Healthy, hygienic conditions for families.
5. Visible differences amongst the slums and richer neighbourhoods which could be responsible for social tensions in slums.
6. Sufficient conventional places because of unplanned and unregulated growth of settlements.

Due to lack of the above facilities, the slums not only have impact on the hutments but also responsible for the overall unsustainable urban environment. After conducting the case study, literature review and observations during various site visits, it is concluded that to achieve sustainability in an urban area, segregated projects related to transportations, link roads etc. are not enough in Mumbai. There is a need to; study pre and post project impacts, different employment opportunities, and spread general awareness about urbanisation along with sustainability. Rehabilitation and resettlement projects will not work if people living in the slums are relocated far away, where there are no employment opportunities. However, in this scenario families will relocate themselves, where work is available resulting in the formation of new slums or promotion of existing slums. For the success of any resettlement, rehabilitation and slum improvement, project location is an important component. In most of the cases people living in the slums do not get a chance to give their opinion about the proposed development. If any of the components of urban area can not satisfy the sustainability criteria and growth is unregulated and not predicated then the urban area cannot achieve sustainability. Moreover, urban sustainability cannot be achieved without the support from the people living in the slums; as they play a major role towards the success of the resettlement and rehabilitation of projects. Often, only one or few of the organisations are working to achieve sustainable development in an urban context and not in collaboration to the rest of the organisations. Because of this, several projects in Mumbai always get delayed and often there are price escalation and obstruction from other organisation or society. For example, if JVLR is considered, there is a difference of more than 50 percent in initial tender cost and the revised cost. The estimated cost as per the tender was INR 660 million and when completed/revised it came to INR 1020 million, and the project is three years behind schedule. Also, the above mentioned costs and time are excluding investment for rehabilitation and resettlement of project affected families (MSRDC, 2007).

5.3 Land tenure

When we studied existing land tenure and how people manage to build their slums, the following interesting facts came into the picture. About ownership of the land, slums and their working is very different (not standard) when compared with the rest of Mumbai. Most of the settlement, so called hutments consists of a number of 'chawls'. Often, a chawl will contend 10-20 small attached units (houses) measuring approximately 100-200 square feet each, which are given on rent by a slumlord (landlord). Also, a number of slumlords own small portions of the land in the settlement. The portion of the land owned by the slumlords is then given on rent with some initial deposit, where the tenant needs to construct their own house and has to pay rent for using the land and not for the house. In the local language this system is known as the "pagadi system" and is widely practiced in many slums in the MMR. Also, this system works very well, as most of the time tenants do not have to vacate their house and keep on paying rent for the small piece of land only, as they are available on long lease.

5.4 Hygiene

After visiting the slums in different parts of Mumbai, a few of them located in Greater Mumbai (Dharavi, Mahalaxmi, etc.) and in the suburbs (Jogeshwari, Vikhroli, etc), the following conclusions are made based on the observations.

Slums which are located in Greater Mumbai are more unhygienic compared to the slums located in the suburbs. It was observed that the slums which are located in the suburbs, collect and throw their garbage on the periphery (if there is an unoccupied land), cleaning internal alleys, galli's (streets) and neighbourhood; ended up surrounding hutment by the piles of garbage. Whereas slums in the city do not have any open spaces on the periphery, resulting in collection of their garbage within their internal streets and neighbourhoods only. However, in both the areas hygiene is below standard.

5.5 Transportation and emergency

As resettlement areas are neatly planned, demarcated in the development plan of the city, it is easy to have planned public transport services. In most of the cases bus stops are located near the resettlement areas. Exact known density and details about the people make it easy to provide all possible public services such as schools, public bus services, ambulances, etc. Also, all of the resettlement areas are approachable by the ambulance and fire fighting vehicles during emergencies. Whereas in the case of slums, all above factors such as density, public profile and their requirements are unknown, making them difficult to plan any activities such as public transport services and other facilities to be used during emergencies. Also, slums don't often have any boundaries and are spread to maximum limits, some time even occupy footpaths, this makes it difficult to locate any common facilities, such as bus stops for public transport and access for emergency vehicles.

6 Summary and conclusion

The research was guided by certain (key) questions, such as 1. What are the factors keeping slums against sustainable urban development? 2. How do slums originate and develop?

Slum inhabitants go through many problems; such as lack of water, healthy air, sewage, solid waste facilities and public transport, migration, pollutions, and shelter shortages. They also face poor ventilation, due to the lack of windows and electricity. Most of the times they tend to establish slums on unused, uncontrolled or reserved lands. As discussed, there are many reasons for the origin of slums and there characteristics make them one of the key players against sustainable development in an urban area (Husock, 2009).

Another reason which leaves a huge chunk of slums untouched by private builders and developers is because the present slum rehabilitation schemes are not financially attractive to them. It is even unviable in some of the suburbs as the selling rate is less than INR 2,000 per square feet" (Dalvi, 1997). Both the above mentioned reasons are the main reasons for the low number of provisions of low cost houses (Iyer, 2005).

The research attempts to explore the slum rehabilitation project in the context of urban sustainability, which is part of the JVLR project funded by World Bank. During the research, it was revealed that to execute any project and to achieve urban sustainability and rehabilitate slums, opinions of people living in the slums need to be considered. In Mumbai, most of the people are living in the slums and it will be difficult to achieve urban sustainability if the slums and employment opportunities are not considered in Mumbai. To achieve considerable sustainability in an urban environment, concerned organisations (governmental and non-governmental) should come together and work in the same line and not individually.

7 References

Allex Gabbay, Subina. S. (2005) Slum Futures. IN BOWER, D. (Ed.) 1-59458-227-0 ed. Mumbai, Bullfrog. (see http://www.bullfrogfilms.com/catalog/l4slum.html , accessed on 12/01/2009)

Allen, J. (2008) Mumbai is racing to prepare for monsoon. International Herald Tribune New York. (see http://www.iht.com/articles/2008/05/28/business/monsoon.php, accessed on 03/02/2009)

CBC (2007) Slum Cities: A Shifting World. CBC.CA. (see http://www.cbc.ca/correspondent/060507.html, accessed on 05/01/2009)

Chauhan, A. (1996) Learning from Slums IN PETER, S. J., GRABNER (Ed.) Minimal space – minimal housing. Austria, The Technische Universitaet Graz, Austria

Dalvi (1997) The Slums of Bombay. Mumbai Pages (see http://theory.tifr.res.in/bombay/history/slums.html, accessed on 05/01/2009)

Dhingra, C., Gandhi, S., Chaurey, A. & Agarwal, P. K. (2008) Access to clean energy services for the urban and peri-urban poor: a case-study of Delhi, India. Energy for Sustainable Development, 12, 49-55.

Dutt, D. (2004) Dream house for Dharavi. Project monitor.(see http://www.projectsmonitor.com/detailnews.asp?newsid=7741, accessed on 12/01/2009)

Giridharadas, A. (2008) Mumbai: City of heavens and hells. International Herald Tribune New York.

Huang, S.-L., Wong, J.-H. & Chen, T.-C. (1998) A framework of indicator system for measuring Taipei's urban sustainability. Landscape and Urban Planning, 42, 15-27.

Husock, H. (2009) Slums of Hope. City, 19.(see http://www.city-journal.org/2009/19_1_slums.html, accessed on 01/03/2009)

Iyer K., Gaikwad S., & Mehta R. (2005) Spin City. Mumbai, Indian Express. (see http://www.indianexpress.com/oldstory.php?storyid=61907, accessed on 26/01/2009)

Jha, S. (2008) Asia's biggest Slum face ruin in development blitz. Crowd Powered Media. Mumbai, Now Public.

Karmayog (2006) Organisations working for Slums Karmayog.(see http://www.karmayog.com/lists/slumorg.htm, accessed on 25/01/2009)

MMRDA (2001) Population and Employment in MMR. Mumbai, MMRDA. (see http://mmrdamumbai.org/docs/Population%20and%20Employment%20profile%20of%20MMR.pdf, accessed on 16/01/2009)

MMRDA (2005) Jogeshwari Vikhroli Link Road-I. IN AUTHORITY, M. M. R. D. (Ed.), MMRDA. (see http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2005/12/27/000160016_20051227132308/Original/RP750v60RIP1JVLR1I010Suppl1.doc, accessed on 10/01/2009)

MSRDC (2007) JVLR widening MUTP. (see http://www.msrdc.org/Projects/P-MUTP2-JVLR_widening.aspx, accessed on 16/01/2009)

Mukherjee, A. (2008) For Mumbai, a shot at urban renewal. International Herald Tribune New York.

Nijman, J. (2008) Against the odds: Slum rehabilitation in neoliberal Mumbai. Cities, 25, 73-85.

O'hare, G., Abbott, D. & Barke, M. (1998) A review of slum housing policies in Mumbai. Cities, 15, 269-283.

Panday P., Mishra A.K.. (2007) Slum-free? Don't even dream. The Economic Times (see http://www.articlearchives.com/government-public-administration/government-bodies/1817792-1.html, accessed on 28/01/2009)

Shetty P., Gupte R., Patil R., Parikh A., Sabnis N., Menezes B., (2007) Housing typologies in Mumbai Mumbai, Collective Research Initiative trust

SPARC (2003) Regulatory guidelines for urban upgradtion the case of Mumbai. Mumbai, Society for the Promotion of Area Resource Centre

UN-HABITAT (2003) Summary of city case studies Part IV. (see http://www.unhabitat.org/downloads/docs/GRHS.2003.4.pdf, accessed on 19/01/2009)

URBAN21 (2000) Sustainable cities Urban21. Berlin, Germany, Regional Environmental Centre (see http://www.rec.org/REC/Programs/Sustainablecities/, accessed on 19/01/2009)

Social capital in urban environments: intersection of theory, research and practice literature

Dr Primali Paranagamage, Prof Andrew Price, Prof. Simon Austin, Ms Fahmida Khandokar

Loughborough University, UK

It is now accepted that the social capital of communities can contribute to beneficial economic and social outcomes in urban development. Social capital theory argues that the structure of social capital is specific to its context and determined by a range of factors, including urban design. Empirical studies into health and crime recognise the contribution of the environment to social capital but little research has been undertaken into the contribution of urban design. This paper attempts to stretch the understanding of the relationship between social capital and attributes of the physical environment through an exploration of the intersection of social capital theory, urban design practitioner guidance and empirical research on social capital that considers the built environment as a variable. Viewing such knowledge through the lens of social capital, the links, overlaps, and extensions were extrapolated thereby attempting to operationalise the theoretical notion of social capital, within sustainability assessment.

The notion of 'social capital' is a theoretical construct, but most authors agree that the concept deals with aspects of social structure that enable social action. Theory suggests that social capital in a neighbourhood can 'grow' over time, and that stability of residency and opportunity for social interaction can help establish the bonds, bridges and networks that build trust and participation. Urban design guidance does not use the term 'social capital', but the content analysis of a selection of urban design guidance revealed twelve recurrent attributes, that encourage people to live, work and relax facilitating either formal or informal interaction and longer term residency in an area, encouraging the growth of social capital. These are movement structure, mixed use, local facilities, ownership, natural surveillance, access and footpaths, sensitivity to context, public space, personalisation, lifecycle needs, mixed tenure, and lifestyle differences. These identified attributes were substantiated through reference to empirical research on social capital and the built environment.

As the physical environment is a recognised 'determinant' in social capital theory, this exercise gives a better understanding on the specificities of the environmental variables, aiding the conceptualisation of social capital. Such a development in social capital theory could contribute to a more prescriptive approach to urban design and planning guidance. It also reveals that if assessment of urban sustainability is built upon knowledge of predictable relationships between variables concerned, a tool to assess the effect of urban development on social capital may yet remain an aspiration. This journey revealed that the built environment is better named as a 'facilitator' of social capital rather than as a 'determinant'. The insight into the variables of the built environment related to social capital, enables a set of proxies to be developed to assess the effect of urban development on social capital, which is the next challenge.

Keywords: assessment, social capital, sustainable housing, urban design, urban sustainability

1 Introduction

It is increasingly accepted that the social capital of communities can contribute to beneficial economic and social outcomes in urban development, such as higher educational attainment, better health, lower levels of crime, more effective forms of government and a growth in GDP[1,2]. It therefore sits alongside other forms of capital namely natural capital (resources, sinks and processes of the flow of energy and material), financial capital (assets that exist in the form of currency that can be owned or traded), manufactured capital (buildings, infrastructure, technologies) and human capital (health, knowledge, skills, output of the individual), in making an important contribution to sustainable development [3].

Social capital theory suggests that its structure is specific to its context and determined by a range of factors, including history and culture, social structure, economic inequalities, social class, ethnicity, and also urban design[1,4]. Although the latter is recognised as a determinant, in-depth discussions about specific features related to definitions, operation or manifestation of social capital is scanty. Likewise, whilst empirical studies recognise the contribution of the environment as a variable in research on social capital and health[5,6,7] and also social capital and crime[8,9] little research has been undertaken by way of linking social capital and urban design. The SUE-MOT (Sustainable Urban Environments- Metrics, models and Toolkits) project worked towards filling this knowledge gap to identify specifically the physical variables that may make a contribution to social capital, with the aspiration of incorporating such knowledge in urban sustainability assessment. The objective of such a quest is not only to mitigate any negative consequences on this important asset but also to deliver development to contribute positively to desired outcomes.

This paper attempts to stretch the understanding of the relationship between social capital and attributes of the physical environment through an exploration of the intersection of three bodies of literature, namely social capital theory, urban design practitioner guidance and empirical research into social capital that considers the built environment as an variable. Viewing such knowledge through the lens of social capital, the links, overlaps, and extensions were extrapolated thereby attempting to operationalise the theoretical notion of social capital, to be useful for sustainability assessment.

The methodology is as follows. Firstly, we reviewed literature on social capital theory, as it was important in its own right to understand the concept, definitions, determinants and therefore the potential of the built environment in contributing to the concept. However, as 'social capital' is a theoretical construct, this has presented problems of operationalisation, namely understanding its actions in urban environments. We then reviewed practice guidance for urban design that suggested that practitioners are involved in the design of places that encourage social capital, although without reference to such a theoretical term. Selected urban design guidance(UDG) [10,11,12,13,14,15,16,17,18,19,20] were then viewed through the lens of social capital theory in a content analysis. Twelve attributes that may contribute to social capital were identified, namely movement structure, mixed use, local facilities, ownership, natural surveillance, access and footpaths, sensitivity to context, public space, personalisation, lifecycle needs, mixed tenure, and lifestyle differences. These were clustered under four themes as connectivity, safety, identity and diversity. Through reference to a third body of knowledge, namely empirical research relating the built environment to social behaviours, we attempted to bridge the gap between social capital theory and urban design. Thus, empirical research provided a medium to interpret the evidenced base of shared experience in more theoretical terms, bridging the gap between social capital literature and urban design. Where necessary, the link between urban design and social capital was further stretched through the insights from social capital theory.

The selected urban design guidance represents a range of organisations in the UK that publishes such guidance, namely from DETR (Department for environment and transport), CABE (Commission for Architecture and the Built environment), Prince's Foundation, JRF (Joseph Rowntree Foundation), Police Department, English Partnerships, and CLG (Communities and Local Government). They were also written for varied purposes such as companions to planning policy, design intervention in housing, guidance to better property value, safety of public space, and social inclusion. The principles of urban design have been extracted from the shared experience of practitioners, on the premise that places can be developed in a way to enable people and communities to achieve their full potential, and that "physical forms and layouts should be designed not to hinder, discourage or distract from this taking place". [14]

2 Implications of Social capital theory to the built environment

The notion of 'Social capital' is a theoretical construct, whose definition has been debated widely in social theory [21,22,23] but most authors agree that the concept deals with aspects of social structure that enable social action.[24] Putnam, a well known theorist of the subject defines social capital as "...networks, norms, and trust that enable participants to act together more effectively to pursue shared objectives"[25] while the OECD (Organisation for Economic Co-operation and Development)also defines social capital as "networks together with shared norms, values and understandings that facilitate co-operation within or among groups".[26] For the World Bank, social capital is "the institutions, relationships, and norms that shape the quality and quantity of a society's social interactions...Social capital is not just the sum of the institutions which underpin a society – it is the glue that holds them together".[27]

Therefore where as human capital is considered an attribute of individuals defined by one's skills, qualifications and knowledge, the concept of social capital refers to an asset generated by being part of a 'community'. The social capital of a group is manifested in social relations, formal and informal social networks, group membership, trust, reciprocity and civic engagement [28]. The World Bank suggests that such manifestation comprises not only a set of horizontal associations between people, but also vertical associations[29] which are commonly distinguished as bonding, bridging and linking social capitals.

Although social capital is recognised as a concept, the understanding between the processes of interaction between the determinants, resultant structures and forms of manifestations are still unknown. The problem can be illustrated in figure 1. Cladridge[4] argues that attempts to build social capital would be ineffective without understanding the underlying determinants that bring about the given structure, but as others only mention 'spatial features' without discussion of such 'features'. This gap in knowledge perhaps explains the lack of research on urban design and social capital.

The ties referred to in figure 1 are also known as types of social capital. Bonding social capital can be expected among close kith and kin, family, friends, neighbours and work colleagues. For example, other than networks of close family and friends, Putnam suggests that ethnic - based organisations or women - based church groups create situations where bonding arises from being alike, manifested in strong ties.[30] Bridging social capital is important to bond together diverse people with different characteristics; an example illustrated by Putnam as civil rights movements, characterised by weaker ties but important for 'getting ahead'.[31,32] The third is recognised to be a vertical bond, linking communities with those in authority with differing levels of power, relating to nature and extent of social ties between clients and providers important for effective delivery of services.[33]

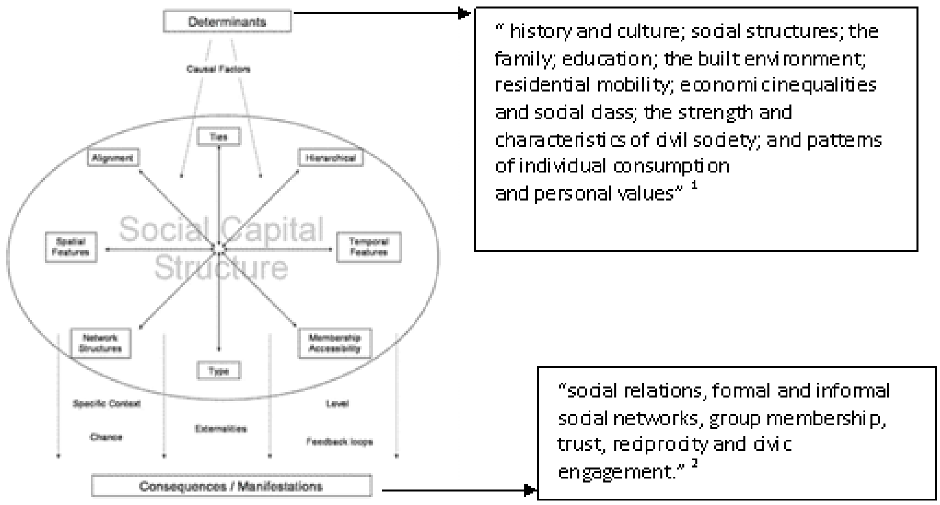


Figure 1: Conceptualization of social capital simplifying the complexity of the social world into a diagram outlining relationships between determinants, structure (or elements) and consequences

note: text boxes on the right were added by author

Source: Cladridge, http://www.gnudung.com/improvedconceptualisation.html

Although, social capital theory is unable to illuminate the physical attributes of urban design influencing social capital, the effect of time is an important consideration. Social capital is known to evolve on a spatial and temporal scale because norms of networks associated with the ties discussed above can diminish with time if there is a decrease in expected returns. However, norms associated with membership or belonging, can be expected to increase over time with reminiscence, resulting in better strength in trust and reciprocity.[4] Measures of social capital (eg. SOCAT) therefore only provide a snap shot at a point in time. Findings of a recent study of social networks and the 'contagion' of happiness underline (among other factors) the relevance of geographical proximity. Findings suggest that friends who lives within a mile could make each other happier and the effects are also seen on neighbours.[34] Aldridge[1] argued that "urban design can also impact on social capital through affording natural opportunities for social interaction in public and semi-public spaces".Cladrige[4] seem to further suggest that designing to retain people in the longer term and providing opportunity for face-to-face interaction could contribute to the element of trust and reciprocity. Therefore, opportunity for face-to-face interaction can foster a sense of belonging and reinforce norms and membership which changes over time. Such a sense of belonging can be expected to grow with increased reminiscence developed by residing in a place in the longer term.

Taking into account the preceding discussion, we defined social capital to be the intangible assets that develop between groups of individuals such as the goodwill/bond/trust arising from shared commonalities, such as values/outlook on life/attitudes, behaviours and relationships/networks that becomes a resource to serve their common goals/needs. Our definition of social capital makes clear that situations created to develop shared commonalities gives rise to intangible assets mentioned. If intangible assets such as goodwill /bond/ trust arise from shared commonalities, can urban development support and promote opportunity for such shared commonalities to develop? Therefore, are there specific features of urban design (generic ingredients and mix) that helps to generate the afore said intangible assets through providing opportunity to develop shared values, behaviours, networks and relationship?

Such opportunity could be for either formal or informal interaction, as it is unclear whether traditional forms of community may have been replaced by 'weaker ties' in the UK [36,37], although the local neighbourhood remains as an important source of social identity as weak ties are known to make an important contribution to social capital in the UK.[38] Spontaneous interactions such as meeting people whilst walking children to school; "bumping into" neighbours and brief conversations or even just waving hello; a visit to the hairdresser; exchanging news or gossip at the post office, encourage a sense of trust and connection between people and the places they live. Accumulated over time, these connections have been theorised to be of significant importance for fostering "a web of public respect and trust" [37], and a resource in time of personal or neighbourhood need. Such interactions are known to be of significant importance resulting in stronger ties amongst older people.[39]

3 The case for social capital in urban design guidance and empirical research

As theory suggests social capital in a neighbourhood can 'grow' over time, stability of residency and opportunity for social interaction can help establish the bonds, bridges and networks that build trust and participation. Acknowledging this 'facilitator role'[40] of the physical environment, Carmona [41] argues, "by shaping the built environment, urban designers influence – inhibit, facilitate, precipitate and modify, but do not determine – patterns of human activity and therefore of social life". This view is also endorsed by Gehl[42], who argues "Although the physical framework does not have a direct influence on the quality, content and intensity of social contacts, architects and planners can affect the possibilities for meeting, seeing and hearing people - possibilities that both take on a quality of their own and become important as background and starting point for other forms of contact".

The content analysis of the selection of documents revealed twelve recurrent attributes, that encourage people to live, work and relax, thus facilitating either formal or informal interaction and longer term residency in an area, thereby encouraging the growth of social capital (Table 1). These attributes could be translated into development criteria, depending on the locality and emerging issues for a particular place, and should be interpreted by designers according to local needs. However, such a discussion is beyond the scope of this paper. Only the abstract thought that relate to the principles of urban design that precedes objectives for development is discussed. The paper only refers to neighbourhood scale as this is the focus of the available research and theory of social capital. This section will first cite the identified attributes from UDG which would then be substantiated and extrapolated with research and theory for their relationship with social capital.

3.1 Cluster 1: Connectivity

3.1.1 Attribute 1: Movement structure .

UDG suggests that "the convenience, safety and comfort with which people go to and pass through buildings, places and spaces play a large part in determining how successful a place will be. Well designed streets encourage people to use them, and make going outside a safe and pleasant experience".[11] In neighbourhoods, the characteristics of such a movement structure include being integrated with existing routes, controlled vehicle movement and speed, legible and attractive to reinforce the character of place and making local shops and services accessible [14,13,18,15]. Such characteristics of streets and public spaces that encourage walking and cycling throughout the day. [14,16].UDG explains in detail how to integrate the network of streets. Recognisable landmarks and intersections within the network of routes with sensitivity to the urban grain (pattern of blocks, plots etc) improve their legibility and attractiveness thereby encourage walking and cycling too. [10,12,17]

Such recommendation may complement Rapoport's argument that the slower speed of pedestrians and cyclists enables them to notice the differences in a streetscape than a motorist, and therefore "a rich pedestrian environment is one that maintains the pedestrians visual and sensory attention".[43] The argument that such 'walkable' neighbourhoods contribute to the presence of people on the streets fostering a sense of community (therefore an expectation of social capital) was suggested by Jane Jacobs in 1961 in 'The death and life of great American cities'.[44] Results from Lund's comparative study of an pedestrian-oriented and automobile-oriented neighbourhood revealed that the sense of community was greater in the former, and that after controlling for demographic influences, features of the pedestrian environment mentioned above significantly influenced the sense of community. [45]

Table 1: Physical attributes of social capital identified from urban design guidance

Key: 1- discussed in depth 2 -discussed reasonably 3 -discussed weakly

Urban design guidance		Identified attributes											
	Date of publication	Mixed use	Movement structure	Local facilities	Ownership	Natural surveillance	Access and footpaths	Context	Personalisation	Public space	Lifecycle needs	Mixed tenure	Catering for difference lifestyles
Urban design compendium	2000	1	1	1	3	1	1	1	3	1	2	2	2
By design – Urban design in the planning system, towards better practice	2000	1	1	2	2	2	2	1	3	1	1	3	1
Better places to live by design	2001	2	1	1	2	2	1	1	1	1	1	1	1
Safer places	2004	2	1	2	1	1	1	1	2	1	2	2	2
Upton design code	2005	1	1	1	3	3	1	1	1	2	3	1	3
Mixed income communities – good practice guide	2006	2	2	2	2	3	3	2	1	2	1	1	1
Valuing sustainable Urbanism	2007	1	1	1	2	1	1	1	3	1	2	1	2
Manual for streets	2007	3	1	3	3	3	1	1	3	1	1	3	1
Secured by design	2008	3	1	3	1	1	1	1	3	1	3	3	3
Building for Life	2008	3	1	3	3	2	2	1	1	1	1	1	1
Inclusion by design	2008	3	3	1	3	3	3	1	1	1	1	1	1
		Cluster 1 Connectivity			Cluster 2 Safety			Cluster 3 Character			Cluster 4 Diversity		

On a similar note Ewing reports that automobile dependence is highly correlated with reducing levels of social participation and capital[43], which also affirms Leyden's argument that compared to car-oriented suburbs, people living in 'walkable' neighbourhoods knew their neighbours better and trusted them, participated politically and were more socially engaged; thus with higher levels of social capital.[46]

3.1.2 Attribute 2: Mixed use

UDG recommends that the provision of a variety of retail, commercial and community facilities that are accessible on foot, through a network of easily permeable routes, encourages people to use them.[11,13] Mixed use streets accommodating a full range of daily needs accessible within a walk of five to ten minutes while major employment centres, secondary schools, large hospitals easily accessible through public transport contributes to the longer term success of neighbourhoods.[14] Ideally, such mixed use "should be well integrated and arranged in a fine grain pattern of buildings within legible blocks and streets" so that not a particular building but the urban form could sustain the mix and change over time as necessary. [17,13,10] Mixed use can contribute to the economy by providing employment for local people by "offering opportunities to live near to the workplace (especially where jobs are low-skilled or part-time), facilitates employment for those for whom a long commute would be both financially unviable and reduce employment choices (eg working mothers)".[14] The benefits of mixed use illustrated in UDG is summarised in figure 2.

Jones suggests that while facilitating social inclusion by attracting a wider population in age and ethnicity, and offering employment opportunity, mixed use streets encouraged social exchange, building social capital and contributes to reduce feeling of isolation and depression in communities.[47] Bailey argued that in 'edge' developments such facilities should be ideally located in the periphery connecting the neighbourhood to the wider area rather than in the 'heart' of a neighbourhood.[16] The importance of mixed use is strengthened in that for many people, the local high street represents the 'hub' of their community attaching a strong sense of local identity. [47] Thus as Leyden suggested provision for a mix of uses in a neighbourhood , makes an important contribution to the growth of social capital.[46]

- More convenient access to facilities
- Travel-to-work congestion is minimised
- Greater opportunities for social interaction
- Socially diverse communities
- Visual stimulation and delight of different buildings within close proximity
- A greater feeling of safety, with 'eyes on streets'
- Greater energy efficiency and more efficient use of space and buildings
- More consumer choice of lifestyle, location and building type
- Urban vitality and street life
- Increased viability of urban facilities and support for small business (such as corner shops)

Figure 2: Benefits of mixed use development

Source : Urban design compendium

3.1.3 Attribute 3: Local facilities

UDG suggests that the range, quality and access of local services and facilities should be enhanced in the delivery of new housing development for the success of a place [10,16,12,14] as they "bring residents together and reinforce community".[11] It is further said that " Public services and amenities support residents and workers, and provide focal elements of an urban structure that help to encourage a strong sense of community and identity. Nurseries, libraries, community centres, police and fire stations and government offices are best placed at central points in highly visible locations. Public squares can be used to emphasise their civic status".[13]

Altchluer [48] and Wood [40] argued that local facilities, services and amenities provide opportunity to be involved in one's community thereby facilitate collective action, develop ties and trust defined as social capital. Baum suggested the need for places to meet outside people's homes, for example, pubs, corner shops, service clubs and sporting grounds, which are named as 'opportunity structures' to maintain loose ties and networks. Such opportunity structures, could be formal opportunities for meeting such as activities in community centres and halls, or recreation or in the opportunities provided for spontaneous meeting as 'community' in today's context was often rooted in mundane and everyday interactions in various localised settings. "For example, with the loss of the post office or local shops, the opportunity to engage in a range of social interactions is reduced because the opportunity for chance meetings is reduced".[37] Schools in walkable distances, local shopping and shared streets that allows people to 'bump' into one another, opportunities for meeting of different age groups (such as older people, teenagers, children etc), or even defined open spaces with benches, play equipment etc contribute to such opportunity to meet.[49] This sense of community is fragile, lost or gained with subtle shifts in how residents perceived any changes to their surroundings.[37] Thus, opportunity structures for informal and formal interaction, can be considered as a facilitator of social capital.

3.2 Cluster 2 Safety

This section on safety lists the three attributes of safety that encourages social capital as understood from UDG, followed by a single discussion based on empirical evidence. This is because evidence for the relationship between separated physical attributes of safety and social capital was difficult to be found.

3.2.1 Attribute 4 :Ownership

UDG suggests that it is possible to design public space which people consider as their 'own', that fosters a sense of belonging. When designed with sensitivity to the needs of the users and with good integration between buildings and external spaces, places encourage social interaction and helps to create a sense of place and identity. Such well used places with a sense of ownership provide fewer opportunities for crime.[15,11] 'Safer places' suggests that this "can be facilitated by clarity in where public space ends and where communal, semi-private or private space begins. Uncertainty of ownership can reduce responsibility and increase the likelihood of crime and anti-social behaviour going unchallenged".[12,10] For example, it is suggested that "Creating well defined open space within communities – a landscaped park, playground or playing field – determines how that space can be used and increases the confidence of space users. Ensuring that the space is well integrated with the broader community and well overlooked also gives it a sense of place and clear purpose."[14,16] How such 'ownership' may be encouraged differs according to local needs and character of place.[11]

3.2.2 Attribute 5: Natural Surveillance

The perception of the sense of personal and community safety does not always relate directly to actual incidence of crime.[12,14] UDG suggests that "design has a crucial role to play in delivering and creating a sense of safety and security. A key issue is that of natural surveillance. Streets which are well overlooked and active throughout the day and evening benefit from the presence and surveillance of residents and visitors.[10,11,20,15] It is known that people feel 'safe' in areas with good visibility and effective lighting, where they can be seen and heard by other people.[40] Therefore it is recommended that "active frontages' be ensured to add 'interest, life and vitality' to the public realm".[13] This means, frequent doors and windows, with few blank walls, narrow frontage buildings, giving vertical rhythm to the street scene, articulation of facades, with projections such as bays and porches incorporated, providing a welcoming feeling; and, on occasion, lively internal uses visible from the outside, or spilling onto the street".[13] On the contrary, there is evidence that 'pavilion' type stand alone buildings with blank facades that create, external spaces without ownership has contributed to high levels of crime.[50] UDG suggests that patterns of burglary in certain neighbourhoods in the UK relates to specific cul-de-sac models and networks of footpaths surrounding dwellings at the back with low movement potential by locals and reduced visibility. Integrated streets which are well connected to local networks had a lower level of incidence in burglary.[14,51]

3.2.3 Attribute 6 :Other attributes of access and footpaths

Other than those discussed above, UDG suggests other attributes that may contribute for the safety of a place, as listed in Table 2. [18,12,15]

Table 2: some attributes of safety in access and footpaths

Source: Adapted from Safer places and manual for streets

Leading people where they want to go	Direct routes for access by foot, cycle or public transport
Ensuring presence of others	Pedestrians, cyclists and vehicles should run alongside and not be segregated, good visibility along footpaths
Keeping interest of people	Good signage, and points of interest such as market stalls, places to sit, street art. landscaping
Convenience of people	The right balance of not too little or too many, therefore unused routes,

The linkage between rates of crime in neighbourhoods and levels of social capital is well established.[52] For example, social capital is negatively correlated with the rates of violent crime such as homicide, assault and robbery, in the states of the USA.[53] The absence of 'social buffers', one of which is formal and informal networks is attributed to high incidence of crime in urban areas.[54] "A study of British crime data found that in areas where people are connected through tight bonds of friendship, and people are active in local committees and clubs, there are fewer muggings, assaults, burglaries and so forth".[53] Perceptions of safety have found to be positively associated with strong trust in neighbours, interactive and reciprocal nature of bonding capital associated with feelings of belonging within the neighbourhood.[6,48] Such finding may complement Hillier's argument that carefully designed streets helps to reduce crime by 'having the entrances of 'opposite neighbours facing each other' and maximising the intervisibility of entrances (including entrances to blocks of flats).[51]

Although such research does not explore whether it is the lower level of crime that had made people stay for a longer term resulting in higher levels of social capital in the area or vice versa, ample evidence exists to confirm that levels of crime and perception of safety can be associated with certain physical characteristics of neighbourhood, that relates to the sense of ownership, provision for natural surveillance and the design of access and footpaths.[40] Therefore, although a direct link between social capital and attributes of safety in urban environments could not be found, the evidence found can be extrapolated as in figure 3.

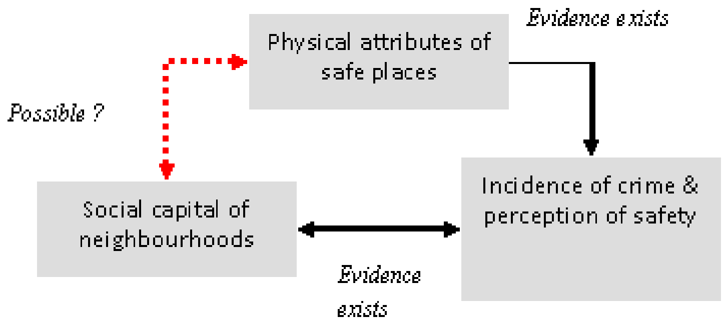


Figure 3 : possible relationship of Social capital and physical attributes for safety

3.3 Cluster 3: Character

3.3.1 Attribute 7: context

UDG emphasises the need to create an identity and a sense of place in neighbourhoods. Each place should respond to local building forms and patterns of development in the layout and design by integrating new development into its landscape, respond to existing building traditions and materials, and patterns of local life to reinforce local distinctiveness. The relationship between the building to building and building to street /open spaces should take into account the urban structure, grain, density, height, massing, details and materials as appropriate to the area; the morphology.[14,11,13] Such sensitivity to context makes one place different from another, and enhances identity of each neighbourhood as "the best places are memorable, with a character which people can appreciate easily".[11]This clarifies the argument that "there is a unit which is larger than the individual home but smaller than the district helps to contribute both to a sense of scale and to a sense of belonging and community". [10,19,20]

Such sensitively developed places facilitate the growth of social capital. Classic work by Wilmott and Young in 1960 suggested that many people's understanding of community relates to certain encounters with local network of friends, family and neighbours that allow individuals to establish 'roots' into a particular place.[55] Central to definitions of a 'sense of community', are feeling of 'belonging' which is generated by emotional attachment to a particular locality and a feeling of 'pride in the place'.[56] People who identified themselves with the neighbourhood, as a unit which is larger than the individual home but smaller than the district, were more likely to have bonding capital, suggesting that a sense of scale adds to a sense of belonging.[48] This promotes a sense of wellbeing that encourages people to retain places as their homes for a longer time allowing social capital to grow. As such, the positive features of a place should be enhanced to create the character of a place, helping to foster ‘belongingness’ and generate ‘feelings of pride’, because once an image is acquired it tends to remain over a long period of time; sometime for generations. [57]

3.3.2 Attribute 8: Personalisation

Housing is said to be at the core in defining a neighbourhood’s identity. Locality is considered a reflection of status, and in the growing private housing market, it is important to the accumulation of personal wealth.[37] UDG suggests that housing and immediate vicinity should provide the owners with enough privacy to enable people to feel at ease within their home and with flexibility in appearance to fix their personal stamp on a dwelling and surroundings, also contributes to the sense of identity.[10,16,19,20,17]

Derbertin refers to shared values manifested in a limited range of home designs, brickwork, colours brass lanterns and the like. These are considered as efforts by the community "to outdo each other while at the same time staying within the bounds of what is considered "ok" for the neighbourhood according to unwritten, but at the same time, very well recognized, norms."[58] He questions whether people do share values more profound than in their choice of brickwork and brass coach lantern and suggests that these elements ‘bind the geographic community as defined by the subdivision together’. Answers and evidence for Derbertin’s question can be found in housing studies, which had researched the latent conformities that underlie the manifested components in the design of domestic space. ‘Space codes’ which reflect norms of communities usually, in a particular geographical area lie beneath the manifested elements, in housing across the world. [59]

3.3.3 Attribute 9: Public space

UDG considers public open space as an important asset in the community. It recommends that the character of public space will vary according to whether such spaces are ‘go to places or destinations for staying, eating, meeting or events, go through or past spaces, such as favoured streets or squares, or stop in places, to sit and watch the world go by; or indeed a combination of all these things – providing multi functional spaces where people live, work and are entertained’.[13 (]. Positioning of public space therefore requires careful consideration as listed in table 3.

Table 3: considerations for positioning of public space

Source : adapted from Urban design compendium

visibility	enabling people to have views with areas to sit or linger in relation to activity 'hot spots',
orientation	South facing sunny and well sheltered spots with seating provide most popular spaces
Activity	Facility for sitting in squares and parks at activity nodes
Playing	Places for children not just designated play areas with spaces for carers to meet.

Such a public realm 'defined' in relation to the activities and surrounding spaces to become intensely used, overlooked and safe spaces to be in, that encourage people to use it (figure 4). [11,12,14,19,17,16]

Cattel and Mass have demonstrated that public space have been a resource for both individuals and communities for social interaction to sustain a sense of community, and to provide opportunities for bonding, making ties and bridges promoting 'well being'.[60 61] There are 'aspects' of public space, which contribute to generate and shape social networks as meanings attached to such space vary between individuals. For immigrants they may be sites of negotiation to make 'home', places of escape for others, places for fleeting or meaningful encounters, to provide relief from daily routines, places for inter-ethnic interactions; such diverse meaning becomes an important consideration in their design.[60] Mundane places such as everyday streets, small parks and squares, market places and even a front drive that allows people to interact with neighbours serve such needs.[62,63] Corti researched the importance of distance, attractiveness and size of public open space to walking – the conclusions of the report show the importance of open space to the community and that good access to large attractive high quality open spaces were associated with higher levels of walking [64], which previous research had suggested could contribute to social capital.

3.4 Cluster 4: Diversity

3.4.1 Attribute 10: life cycle needs

UDG suggests that successful places have the adaptability to changing circumstances and are inclusive to diverse needs of people. Although there are many ways in which people live, travel and work, "the basic structure of the physical fabric of such (successful) places proves to be grounded in unchanging patterns of human life, rather than being unalterably fitted to some very specific purpose".[10,16,18] Inclusive places and neighbourhoods, recognise the differences arising out of differences in lifestyle, economic circumstances, lifecycle, ethnicity and gender, abilities / disabilities and have respected and accommodated them in physical environment.[11,12,14] UDG further reveals that mixed neighbourhoods "enable community self-help such as with arrangements for child care, help with shopping, the garden or during the winter freeze; assist community surveillance with people coming and going throughout the day and evening, as compared to the dormitory suburb which becomes deserted during the working day, making the opportunities for crime easier".[10] Public space too, with flexibility to accommodate events such as markets, festivals contribute to the diversity and adaptability of a place.[11, 20]

Research suggests the importance of allowing for changing needs across the lifecycle as place attachment, does create trust and reciprocity. For example, the attachment to a place in older age, constructed by long residency helps develop trusting and reciprocal relationships with neighbours.[65] Allen argued that for communities to be sustainable in the longer term, people should be able to move in the same area throughout the life cycle when needs change.[66] Silverman suggested that the transient nature of inner city neighbourhoods could be attributed to the non- availability of family housing, as these catered mainly to couples and single households.[67] Therefore, different densities, types of housing, a range of housing to suit people's needs across life span are known ingredients of that make people live in the area for a longer term. This may often involves the resolution of conflicting needs due to the diversity of people that are expected to occupy. Such evidence enables to stretch our understanding that providing for needs across the life-cycle could contribute to social capital by providing for longer term residency as understood from theory.

3.4.2 Attribute 11: mixed tenure

UDG emphasises the need to have adaptability to changing circumstances to be inclusive to diverse needs of people. Sustainable urbanism should promote social integration, mitigate the stigma associated with social housing and reduce social exclusion.[10,17,19,20] For this purpose, it is recommended that a choice of tenures within a range of housing sizes and types be provided to promote such inclusion.[14] "Mixed tenure cannot on its own improve communities or reduce social exclusion and poverty, but when it is part of a number of initiatives such as high quality physical environment and the provision of a range of local services it can contribute significantly towards creating a sustainable community providing a higher quality of life and an opportunity for those who are economically challenged to break out of the spiral associated with concentrated disadvantage".[14,16] Close analysis of local housing markets, and integration of mixed tenure neighbourhoods with other services in the area, such as schools, shopping, health and leisure that cater for lifestyle differences, contribute to inclusive places to grow.[16]

The importance of designing for mixed tenure, is renewed in the light that decreasing levels and class specific participation suggests a decline in social capital in the UK. [68,69] Neighbourhoods could help increase social inclusion by providing a mix of housing types for differences in affordability thus contributing to bridging social capital, if differences may not allow for bonding. Berube pointed out that concentration of deprivation is associated with other disadvantages such as high unemployment, low performances of schools, high levels of crime and health inequalities, which make people move out from an area.[70] Roberts argued that 'shared streets' that can be used by different tenure groups such as social and private tenants and owner occupiers, increases the chances of spontaneous interaction, thus help build social capital. [49] Thus, providing for mixed tenure facilitates desirable places to live in the longer term.

3.4.3 Attribute 12: Catering for different lifestyles

UDG suggests that "The location and design of a place, its facilities, and equipment inside may fail to take into account minority cultural or religious requirements such as space for prayer and washing facilities or numbers of rooms. The impact of bad design is more likely to be felt by disabled people and older people, people from minority cultures and faiths, carers with young children, and therefore has a disproportionate effect on women.[20,19,11,10] It further acknowledges that "sustainable and socially cohesive communities are built on the bonds that unite rather than the differences that separate" and recognises that "good design can contribute to a sense of belonging and foster good relations between and within communities". Although the term social capital is not mentioned, it is said that "our sense of being at ease and belonging are strengthened by positive contact with neighbours and by being involved together in decisions about the spaces and places we share".[20] It is suggested that this "may often involves the resolution of conflicting needs due to the diversity of people that are expected to occupy. Therefore it is the resolution of these needs, that are localised to the context that have to be arrived at". [14]

When neighbourhoods are designed for diversity, facilities should also be provided for differences in lifestyles.[71] For example if neighbourhoods accommodate different densities accommodating housing for couples, singles and families, the differences in lifestyles between the groups would demand a variety of services and facilities to sustain them. Hence if higher densities can be expected, this may also contribute to avoid urban sprawl that makes people dependent on cars while supporting a variety of services and mixed uses and viable public transport provision.[72] Thus, once again such places allow people to live in the area for a longer term, facilitating social capital to grow.

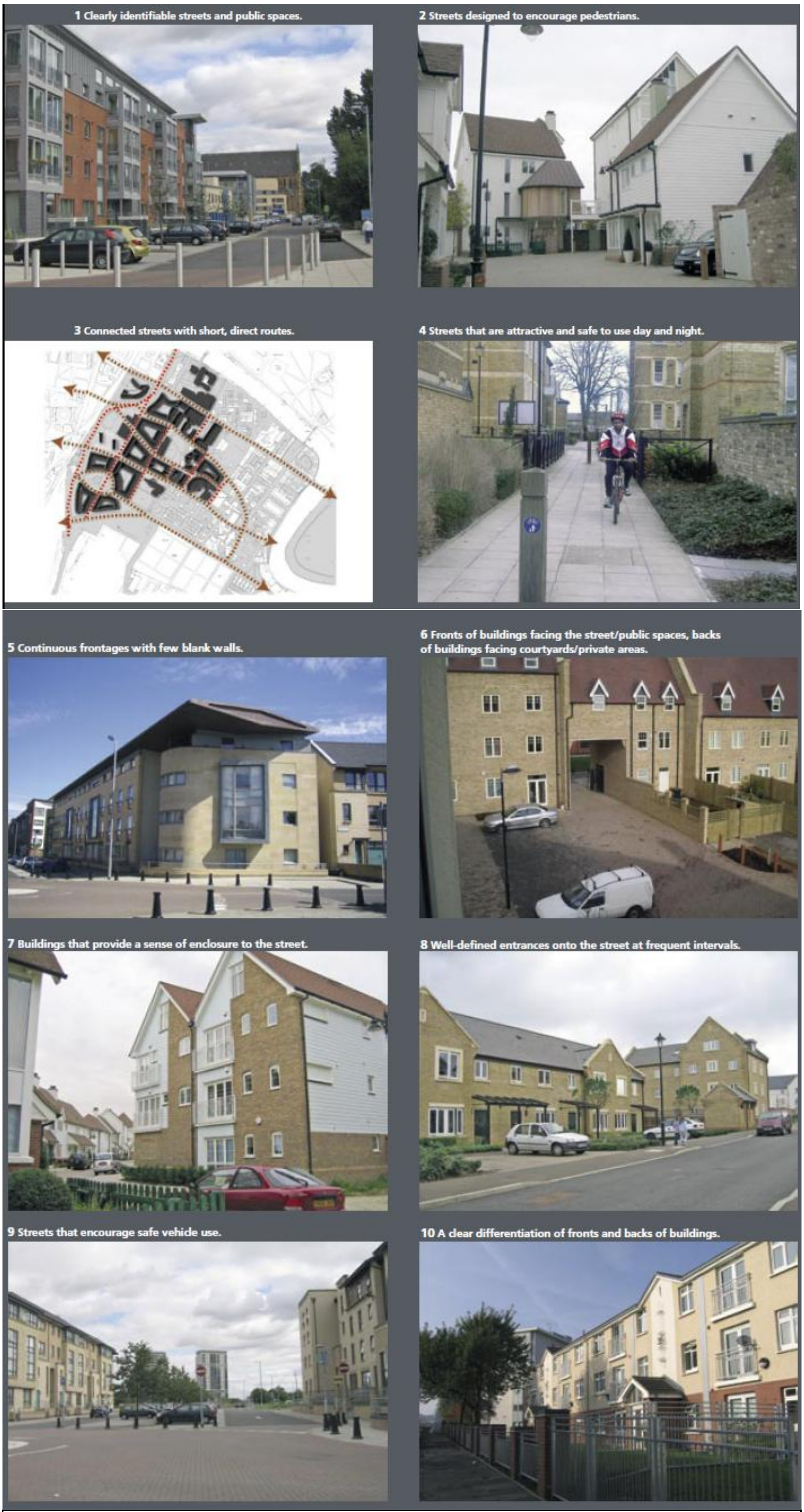


Figure 4: Attributes of sustainable public space

Source: adapted from Creating and sustaining mixed income communities: a good practice

4 Discussion

What are the lessons learnt in this attempt to link three bodies of literature, namely social capital theory, urban design guidance and research on social capital and environment? How does it inform sustainable urban development?

Cladridge concludes that "to date, attempts to conceptualize social capital have not taken into account the complexity of interactions between determinants, structural elements and consequences or manifestations. The result is a tenuous link between the operationalisation and theoretical understanding of the concept".[73] This paper was a journey to operationalise the concept by identifying the linkages and relationships to UDG, substantiated by empirical research. Although Social capital theory recognises the physical environment as a 'determinant', this exercise suggests that its role is that of a 'facilitator'. This is because, the built environment could only facilitate the growth of social capital, by providing opportunity for interaction and create the conditions for longer term residency in an area. By doing so, it can only make provision to develop shared values, outlooks, attitudes and behaviours but cannot determine the forms of manifestations, such as trust, reciprocity and good will that arises from the former; which is defined as social capital.

This exercise also provided more in depth understanding on the specificities of the environmental variables that facilitates social capital, thus aiding its conceptualisation and contributing to the development of theory. The twelve attributes discussed made clear that the range and interrelations of neighbourhood characteristics that could affect social capital are more complex than currently dealt with in empirical research. For example, although research provides strong evidence for a relationship between identity, belonging, sense of place and social capital, there is not much discussion on the physical variables contributing to such sense of place. Perhaps, the physical attributes can now be elucidated in more definitive terms, informing future empirical research from the evidence base of the urban design practitioner.

What are the implications for the aspiration to incorporate 'social capital' in urban sustainability assessment? Even with the difficulties in operationalising within the state of knowledge in its conceptualisation, social capital theory could provide the practice of urban design with more definition to convince messages to the targeted audiences. For example Dempsey[74] point out that much of policy and practice documents refer to a 'high quality' of spaces where 'quality' is left to interpretation. The linkages between the twelve attributes identified, manifestation of social capital and beneficial outcomes such as in crime and health could perhaps now be illustrated better, enabling the effective delivery of the message, allowing assessment to be more prescriptive in return. For example, assessment tools such as Building for Life or SEEDA (South East England Development Agency) sustainability check list that deals with aspects of social capital, could pin down the criteria in definitive terms with this insight. Associated terms such as social cohesion, and social interaction being phrases with more practical understanding may prove useful too, to make the case for incorporating social capital in developments policy, practice and guidance.

However, it also reveals that if assessment of urban sustainability is to be built upon knowledge of predictable relationships between variables concerned, a tool to quantify the effect of urban development on social capital may yet remain an aspiration. Variables related to physical attributes of a place if considered as the 'cause' that needs careful consideration to result in desired 'effects' of social capital, the subject is yet debated with much controversy. Research on space and social behaviours can only understand the relationships as a snap-shot in time, as research suggests that it is difficult to identify which determines and precedes the other, space or the behaviours or whether the results can be considered as an interaction, each moulding the other[75]. Many intervening variables which are considered to be 'intangible' moulds the results too, the effects of which are difficult to eliminate.[76] For example, if one were to research on natures of social interaction while walking to a destination, the nature of socialising would differ according to other variables related to the persona of the individuals in question.

However, knowing the influencing physical attributes, would enable a set of proxies (for example, land use measures may be an indicator of mixed use and measures of integration and connectivity could inform some of the attributes of walkability) and at most a protocol to be developed to aid assessment, which is the next challenge ahead.

5 References:

1Aldridge S et.al Social Capital, a discussion paper Performance and Innovation unit, Cabinet Office, London 2002

2Harper R Social Capital, A review of literature, Office of national statistics, UK 2001

3Forum for the future http://www.forumforthefuture.org/our-approach/tools-and methodologies/5capitals 2007

4Claridge T http://www.gnudung.com/literature/determinants.html

5Macintyre S et al. Social and local variations in the use of neighbourhoods: a case study in Glasgow Health and place, vol 4, 1998

6Baum F Opportunity structures': urban landscape, social capital and health promotion in Australia Health promotion international, vol 17,no4 2002

7Kawachi I, et al . Social capital and self-rated health: a contextual analysis. Am J Public Health. 1999

8Lindstorm M Social capital and sense of insecurity in the neighbourhood: a population-based multilevel analysis in Malmo, Sweden Social Science & Medicine 56 2003

9Kawachi, I., Kennedy, B. P. &Wilkinson, R. G. Crime: Social disorganisation and relative deprivation. Social Science & Medicine, 48, 1999

10Better Places to Live by Design: A Companion Guide to PPG3, CABE 2001

11By design: Urban design in the planning system, towards better practice, DETR 2000

12Safer places, The planning system and crime prevention – Office of the deputy prime minister 2004

13Urban design compendium, English Partnerships and Housing corporation 2000

14Valuing sustainable Urbanism, The Prince's foundation 2007

15Secured by design Principles, Police Department 2008

16Creating and sustaining mixed income communities, good practice guide – Bailey N et.al, Joseph Rowntree foundation 2006

17Upton design code - Northampton Borough council, English partnerships, The Prince's foundation 2005

18Manual for streets – Communities and local government, Department for Transport 2007.

19Building for Life – CABE 2008

20Inclusion by design – CABE 2008

21Bourdieu P. (1986) The Forms of Capital in Baron S. et.al (eds.) SocialCapital - Critical Perspectives. Oxford University Press. 2000

22Coleman J. Foundations of Social Theory, Harvard University Press Cambridge. 1990

23Halpern D. Social capital: the new golden goose. Faculty of Social and Political Sciences, Cambridge University. Unpublished review. 1999

24Adam F et.al 'Social Capital: Recent Debates and Research Trends.' Social Science Information 42, 2003..

25Baron S et.al (eds) Social Capital - Critical Perspectives. Oxford University Press. 2000

26Cote S et.al. The Well-being of Nations. The role of human and social capital, Organisation for Economic Co-operation and Development, Paris 2001.

27World Bank social capital web site http://www.worldbank.org/poverty/scapital/index.htm.

28Sander, T et.al, Social capital building toolkit, version 1.0, John F.Kennedy School of Government, The Saguaro Seminar, Harvard University. 2003

29World Bank social capital web site http://www.worldbank.org/poverty/scapital/index.htm.

30Putnam, R. Bowling Alone - The Collapse and Revival of American Community New York: Simon & Schuster. 2000

31Narayan D. Bonds and bridges: social capital and poverty. in Social Capital and Economic Development: Well-being in Developing Countries, edited by Sunder Ramaswamy. Cheltenham, UK: Edward Elgar. 2002

32Granovetter, M. The Strength of Weak Ties American Journal of Sociology 78,1973

33Woolcock, M et.al "Social capital: Implications for development theory, research, and policy." The World Bank Research Observer 15: 225-249, 2000.

34Fowler et.al Dynamic spread of happiness in a large social network: longitudinal analysis over 20 years in the Framingham Heart Study BMJ 2008;337:a2338

36Ray F et.al, Social Cohesion, Social Capital and the Neighbourhood, Urban Studies 38, 2001

37Robertson D et.al Neighbourhood identity, People, time and place, Joseph Rowntree Foundation 2008

38Groves et.al Neighbourhoods that work: A study of the Bournville estate, Birmingham, The Policy Press and Joseph Rowntree Foundation 2003)

39Walker R, Places and health: A qualitative study to explore how older women living alone perceive the social and physical dimensions of their neighbourhoods, Social Science & Medicine 65, 2007

40Wood L et.al 'Is there a place for social capital in the psychology of health and place?' Journal of environmental psychology, 2007

41Carmona M et.al Public places Urban spaces, The dimensions of urban design, Architectural Press, Oxford 2003

42Gehl J Life Between buildings: Using public space, Arkitektens Forlag, Skive 1996

43Ewing R et.al Understanding the relationship between public health and the built environment A report prepared for the LEED-ND core committee

44Jacobs J Death and life of great American cities Newyork Random house 1961

45Lund H, Pedestrian Environment and sense of community, Journal of planning education and research 2002

46Leyden, K.M. 2003: Social capital and the built environment: The importance of walkable neighbourhoods, American Journal of Public Health, Vol. 93, 2003

47Jones, P et.al, Rediscovering MixedUse Streets (Public Space Series); JosephRowntree Foundation. 2007.

48Altschuler A et.al Local services and amenities, neighborhood social capital,and health, Social Science & Medicine 59 ,2004

49Roberts M Sharing space: Urban design and the reduction of social distance in new mixed income communities, Planning theory and practice 2007

50Hulme Ten Years On: Draft Final Report to Manchester City Council, Centre for Sustainable Urban and Regional Futures (SURF), University of Salford 2002

51Hillier B, can streets be made safe? http://www.spacesyntaxlaboratory.org

52Kawachi, I. et.al Crime: Social disorganisation and relative deprivation. Social Science & Medicine, 48, 1999.

53Lindstorm M. Social capital and sense of insecurity in the neighbourhood: a population-based multilevel analysis in Malm. o, Sweden, Social Science & Medicine 56 2003

54Wilson, W. J. The truly disadvantaged: The inner city, the underclass and public policy. Chicago: University of Chicago Press. 1987

55Wilmott et.al Family and kinship in East London 1971

56McMillan, D. W. et.al Sense of community :a definition and a theory. Journal of Community Psychology, 14,.1986

57Andrews C et.al Challenging perceptions: case studies of dispersed and mixed tenure new build housing ,Sovereign Housing/Housing Corporation 2005

58Debertin D A Comparison of Social Capital in Rural and Urban Settings, http://www.uky.edu/~deberti/socsaea.htm 2008

59Hanson J etal. Decoding homes and houses, Cambridge University Press 1998

60Cattel V, Mingling, observing, and lingering: Everyday public spaces and their implications for well-being and social relations, Health and Place 14, 2008

61Mass J et.al Social contacts as a possible mechanism behind the relation between green space and health, Health and place 2009

62Roberts M et.al (eds) Approaching Urban design: The design process

63Watson S et.al Markets as social space, Joseph Rowntree foundation 2006

64Giles-Corti el at. 2004. Increasing walking. How important is distance to attractiveness, and size of public open space?

65Scharf, T Older people's perceptions of the neighbourhood: Evidence from socially deprived urban areas. Sociological Research Online, 8(4) 2003

66Allen C et.al Mixed tenure twenty years on – Nothing out of the ordinary, Chartered Institute of Housing and Joseph Rowntree Foundation 2005

67Silverman E, et.al A good place for children? Attracting and retaining families in inner urban mixed income communities, Chartered Institute of Housing and Joseph Rowntree Foundation 2006

68Grenier, P Social capital in Britain: an update and critique of Hall's analysis, CCS International Working Paper Number 14

69Warde A Trends in Social Capital: Membership of Associations in Great Britain, 1991–98 British Journal of Political Science 33, Cambridge University Press, 2003

70Berube A, Mixed communities in England: A US perspective on evidence and policy prospects, Joseph Rowntree Foundation, 2005

71Meen G et.al Economic segregation in England: Causes, consequences and policy, Joseph Rowntree Foundation 2005

72 McCann, B et.al Measuring the Effects of Sprawl: A National Analysis of Obesity and Chronic Disease. Smart Growth America special report. 2003

73 http://www.gnudung.com/conclusions.html

74Dempsey N , Does the quality of the environment affect social cohesion? Urban design and planning DP3 2008

75Hillier B et al. The social logic of space, Cambridge University press 1989

76Cooper R et.al Mental Capital and Wellbeing:Making the most of ourselves in the 21st century: State-of-Science Review: SR-DR2The Effect of the Physical Environment on Mental Wellbeing, Government office for science, 2008

Barriers to the adoption of sustainability assessment tools in strategic decision making

Ms Fahmida Khandokar[1], Prof Andrew Price[1], Dr Primali Paranagamage[1], Dr Monjur Mourshed[1], Prof. Simon Austin[1], Dr Cletus Moobela[2]

1 – Loughborough University, UK

2 – University of Portsmouth, UK

The ubiquitous drive towards a more sustainable future has resulted in major changes in the planning and design of urban environments. Government strategies on sustainable development, published in 1999 and 2005, are thought to be driving the development of new legislations that are aimed at delivering a sustainable future for the UK. As a result, conventional stand-alone approaches to decision making in strategic planning are being replaced by more participatory and evidence-based approaches. These focus on achieving sustainability by taking into account the dynamic interactions between social, economic and environmental aspects of urban environments. The sheer volume of complex urban issues, the multiplicity of stakeholders and their varying values and diversity of viewpoints - all contribute towards making urban sustainability and its assessment an intellectually challenging task. Many tools have been developed to aid the decision making process by assessing the impacts of urban projects throughout their lifecycle. Sustainability assessment (SA) tools range from the assessment of a single indicator within a given context to the integrated assessment of a wide range of indicators covering many facets of sustainable development. However, the adoption of SA tools in decision making for strategic planning remains low.

This paper reports on the findings of the research aimed at the identification and classification of the factors that had the potential to hinder or encourage the adoption of SA tools during the preparation of a local strategic plan. Based on the findings of a review of relevant literature, a questionnaire survey, follow-up interviews and a case study, the application context of SA tools was identified. To better understand the barriers to the adoption of SA tools, concepts from information sciences were taken into account. The findings reveal that in the complex platform of decision making, the adoption of tools is often constrained by the chain effects of interconnected barriers relating to technology, people and resources. The lack of appropriate tools to serve the demands of the sustainability assessment process and the lack of relevant expertise are the major barriers to the adoption of SA tools. Emerging policy context calls for robust and integrated tools that will perform efficiently to guide the decision making process. Joined-up efforts are required from academia and industry to develop the SA tools and to enhance professionals' skills in the application of SA tools to meet the challenges of sustainability decision making in an emerging policy context.

Keywords: barriers, strategic planning, sustainability assessment, tools, urban development

1 Introduction

The ubiquitous drive towards a more sustainable future has resulted in major changes in the planning and design of urban environments over the past couple of years. Government policies on sustainable development (DETR 1999; HMSO 2005) are thought to be driving the introduction of new legislations such as Planning and Compulsory Purchase Act (OPSI 2004), aimed at delivering sustainable urban developments at local and regional levels. Under the new approach, strategic planning at a local level has received renewed interest as a vehicle to achieve overall sustainability by setting out the framework for future developments of the area. Another major development is the departure from stand-alone and ad-hoc approaches (Zellner et al. 2008) in decision-making towards more participatory and evidence-based approaches. The local planning authorities (LPA) are now obliged to conduct sustainability assessments as part of the strategic plan preparation process. Sustainability assessment is applied as a means to generate the required evidence base that informs and structures the decision-making process to ensure the robustness of the proposed strategies with reference to sustainable development. The assessment process involves assessing the significant social, economic and environmental effects of the proposed strategies considering the observed local trends of the urban system. The dynamic nature of urban development, often influenced by the inherent uncertainties and complexities of population growth, economic activities, resource usage and assimilative capacity of the natural environment, complicates the matter further. The sheer volume of urban issues, the multiplicity of stakeholders and their varying values and diversity of viewpoints - all contribute towards making urban sustainability and its assessment an intellectually challenging task (Moobela et al. 2007).

A number of tools have been developed to assess sustainability at various lifecycle stages of urban development strategies and projects. Sustainability assessment (SA) tools range from the assessment of a single indicator within a given context to the integrated assessment of a wide range of indicators covering many facets of sustainable development. However, the adoption of SA tools in decision-making for strategic planning remains low. Rotmans (2006) reported that more than 90% of currently available sustainability assessment tools have never been used by clients or users. Therefore, it is important to understand the factors that inhibit the adoption and use of SA tools for strategic decision-making in an emerging policy context.

Previous research focused mostly on the barriers to sustainability in general, with little reference to SA and adoption of tools. A few studies attempted to identify the barriers that had limited the uptake of SA at a project level (e.g. Wilkinson and

Reed 2007). However, it has been argued that there exist differences between the barriers to sustainability assessment and the adoption of sustainability assessment tools (Moobela et al. 2006); mainly in the context of behavioural, institutional, economic and technological aspects. Against this background and considering the significance of strategic decision-making in sustainable urban development, this research aims to investigate and identify the barriers to adoption of sustainability assessment tools over the lifecycle of a strategic plan.

The rest of the paper is structured as follows. The next section describes the methodologies adopted in this research. The subsequent sections discuss the application context of SA and the barriers to the adoption of SA tools in practice. Finally, the paper concludes with a discussion on the implications of this research as well as future directions.

2 Methodology

This study focussed on exploring the barriers to the adoption of sustainability assessment tools in emerging evidence-based and participatory decision-making in strategic planning. The research methodology was based on a systematic approach involving a combination of literature review, a questionnaire survey, follow-up interviews with practitioners and a case study with a UK local authority. To contextualise the research and findings in the emerging policy context, national and local policy documents were reviewed to gain insights into the lifecycle stages of a strategic plan of a Local Development Framework (LDF). This resulted in a general protocol, which was later validated by industry stakeholders through follow-up interviews. The protocol also provided a basis for subsequent investigations in this research.

The questionnaire survey was designed to fill in the information gaps of the literature review. The survey was conducted among the strategic sustainability assessment practitioners from both private and public sectors across the UK. The aim was to collect their views on sustainability assessment tools and the factors that had hindered the adoption of such tools in practice. Local authorities for the survey were selected based on their geographical locations to ensure a representative sample. Out of the 100 questionnaires sent, 34 were returned. Follow-up interviews have been conducted to complement the findings of the questionnaire survey.

As sustainability assessment is aimed at generating an evidence-base for informed decision-making, the case study investigated the key tasks associated with the preparation stage of a strategic plan. To understand the relationship between the key elements and the application context of SA tools, information flow in the decision-making process has been explored. Finally, the key factors that contribute to the non-usage of sustainability assessment tools during decision-making were identified and grouped under three categories based on the survey responses and the most cited literature.

3 Applications of SA tools in strategic planning

Sustainability assessment at a strategic planning level should analyse the multiple causes and effects of complex urban problems with a view to developing policy options for a strategic solution. SA helps policy makers to get an insight into the dynamic interactions and complexity of social, economic and environmental parameters of sustainable development; e.g. economic growth, resource usage and assimilative capacity of the natural environment (Hopkins 1998). These indicators are analysed over a period of time taking into considerations the observed local and national trends.

To explore the applications of sustainability assessment tools in strategic decision-making, the lifecycle stages of a strategic plan was examined. It should be noted that the UK planning system has gone through a major reform in recent years to promote sustainability and to enhance the efficiency of the decision-making process. One of the significant changes was the restructuring of the strategic decision-making process where it became mandatory for planning authorities to undertake sustainability assessment during the preparation of a strategic plan.

The lifecycle of a strategic plan can be categorised into three key stages: production/preparation, implementation and monitoring and review (DCLG 2004). Stakeholders' involvement in all three lifecycle stages has been illustrated in Figure 1. Once the plan preparation process is finalised, it sets out the framework for implementation of the plan allowing for project level development. During implementation, the projects that may have a significant impact on the built environment requires a sustainability assessment to be conducted before applying for planning permission. At the final stage, the performance of the strategic plan is monitored on a regular basis against the implementation plan at a project level. As a good practice some local authorities conduct sustainability assessments to review effectiveness of the policies of the strategic plan.

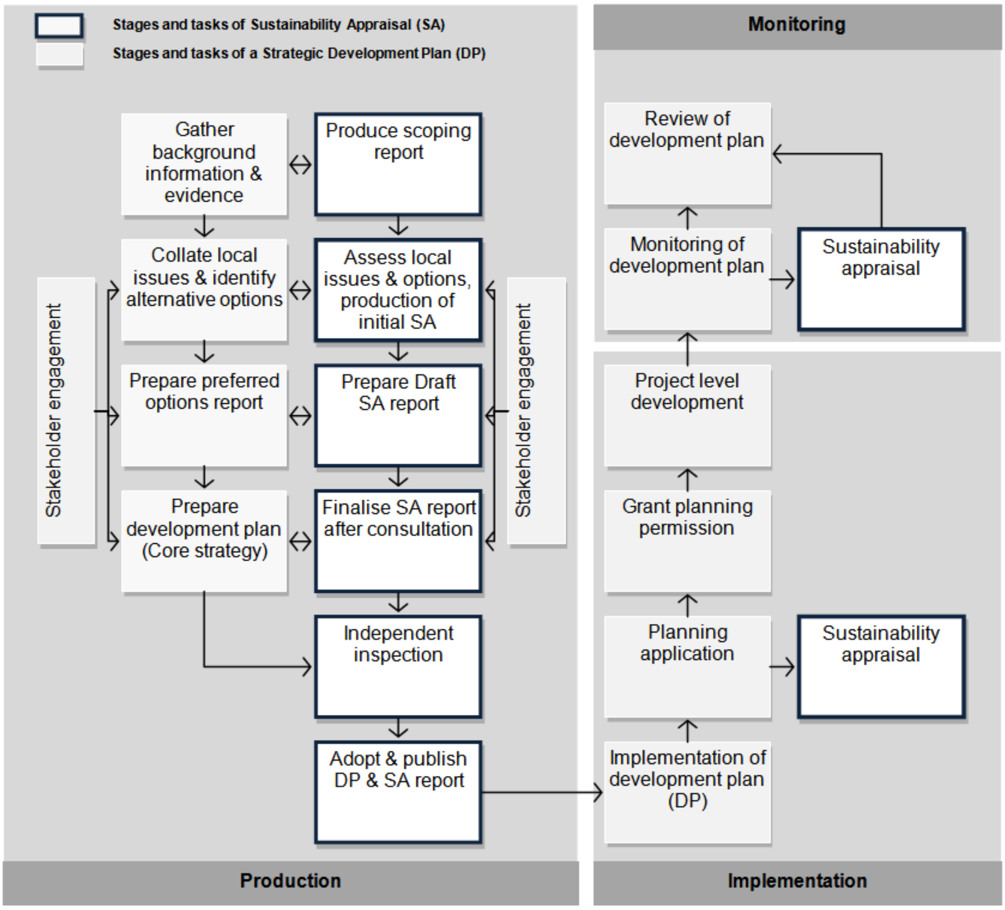


Figure 1: Lifecycle stages of a strategic plan.

The process of sustainability assessment encompasses a set of interrelated and iterative activities. It is reported that effective decision-making for sustainability often depends on the activities that help to maintain a consistent flow of reliable and accurate information in an organisational setting (Watson et al. 2005). These activities range from the identification of sustainability indicators to the development and validation of the preferred option(s). Based on the case study, this research identified key activities that are associated with information flow; in other words, the activities associated with the production of the evidence base. Figure 2 illustrates the tasks involving information flow within a sustainability assessment. The tasks depicted are: the identification of sustainability indicators and information capture, storage, access/retrieval, processing/analysis, modelling and dissemination.

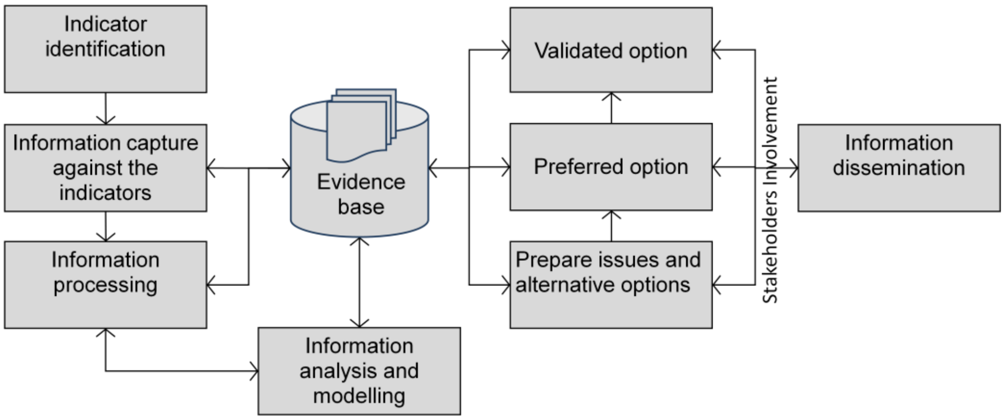


Figure 2: The tasks involving information flow within sustainability assessment.

4 Barriers to Adoption

In the current policy setting, sustainability assessment often requires decision makers to deal with complex and poorly defined/structured urban problems (Rotmans 2006) and take into account diverse perspectives of stakeholders in an environment full of uncertainties. According to Hopkins (1998), the modern decision-making tools are expected to meet the multidimensional demands of the assessment work, which include but are not limited to the:

- simultaneous evaluation of impacts from interrelated development parameters of a plan;
- generation of alternative plan options;
- performance prediction of the generated options; and
- management of a large volume of information to facilitate communication between processes and stakeholders.

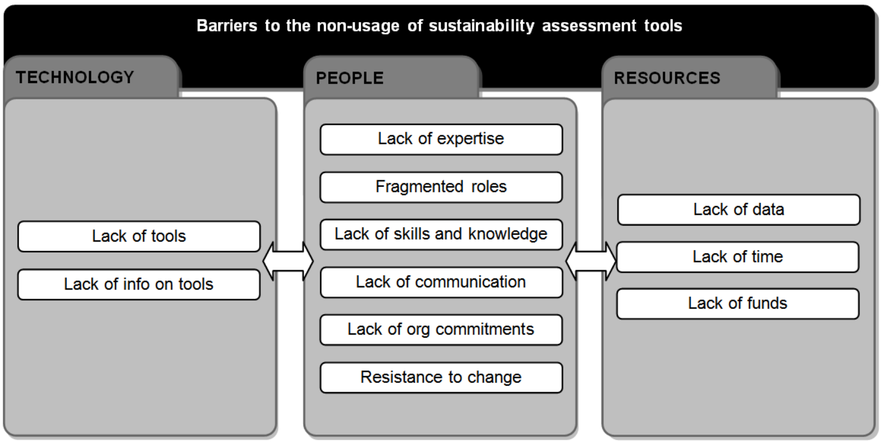
Successful application of tools offering the range of services, described above, is likely to improve the efficiency of the decision-making and thereby contribute to sustainable development. Limited resources and organisational uncertainties often constrain the application of such decision-making tools in practice. Against this background, concepts from information science were considered to identify the key barriers to the adoption of SA tools in strategic planning. Adoption of tools or systems in an organisation often relies upon three aspects: people, resource and technology (Mustapha and Sayed, 2006). Based on the findings of the questionnaire survey the key barriers to adoption have been grouped under these headings, as shown in Figure 3, to structure the discussion on the survey results that follows.

4.1 Barriers associated with technology

The majority of the survey respondents use the Sustainability Assessment Framework (SAF) Sustainability Appraisal Metrics (SAM), developed according to the Department for Communities and Local Government directive (DCLG 2005), as the primary tool to assess sustainability at strategic planning level and to comply with the statutory requirements. However, the following limitations of SAF/SAM were identified by the respondents:

- lack of clear guidance and standard methodology for conducting SA;
- limited scope for quantitative analysis;
- resource intensive nature of the tools; and
- reliance on subjective measures for decision-making.

The findings are in line with the previous study by Hurley et al. (2008), which argues that the SAF/SAMs are useful for setting the context of the decision-making process but are inadequate to capture the essence of the complex



problems involving a variety of actors with different perspectives.

Figure 3: Major barriers to adoption of sustainability assessment tools.

More than half of the respondents cited occasional use of other SA tools alongside SAF/SAM. The commonly used tools were:

- Resource and Energy Analysis Programme (REAP) (Barrett et al. 2005);
- BRE Environmental Assessment Method (BRREAM) (Brownhill and Rao 2002);
- Bespoke metrics;
- Ecological footprinting;
- The Aalborg Charter (ESCTC 2001);
- Geographical Information System (GIS); and
- Quality of Life Assessment (QLA).

GIS is the tool of choice for spatial analysis and visualisation of environmental constraints. When asked about the non-usage of SA tools other than SAF/SAM on a more regular basis, some of the respondents cited the non-availability of user-friendly tools capable of analysing and predicting a wide range of issues in an integrated way. This finding echoes with that of the past studies; e.g. a study by Brown et al. (2006) identified that most SA tools were designed to assess specific aspects of sustainability and in most cases the environmental dimension only. Such tools restrict the stakeholders from getting an understanding of the complex interdependence of socio-economic and environmental issues of the strategies in question.

The lack of support for effective information management among SA tools was another important issue raised by the respondents. The management of the large volume of information generated for and by the SA process was essential to the respondents for effective collaboration among stakeholders as well as for enhancing public participation in the planning process. Some practitioners found the existing information management systems to be inadequate to cope with the demanding and iterative nature of SA. This finding is supported by the existing literature that highlighted the need for new and improved technical tools to increase the quality, diversity and impact of participation on planning and policy outcomes (Elwood 2002, Innes and Booher 2000, Innes 1990, Goelman 2005, Holden 2000). Modern SA tools need to be designed to allow the assessment and visualisation of the state of the urban area taking into account the wider implications of a proposed strategy in a varying temporal scale (Kapelan et al. 2005, Rotmans 2006). Key criteria for such tools are can be summarised as:

- integrated assessment of sustainability;
- systematic risk and uncertainty modelling;
- advanced impact assessment;
- user-friendly visualisation of the decision parameters;
- effective management of shared repositories of information; and
- innovative and interactive calibration and validation of the underlying models.

Among other factors, the lack of appropriate information about SA tools has been cited as a limiting factor for their uptake in practice.

4.2 Barriers associated with people

It is acknowledged that sustainability assessment is an intellectually challenging task requiring a diverse range of skills and assimilative knowledge on the components of sustainability. The key skills associated with the SA are:

- the ability to identify and assess significant local issues;
- competence in qualitative and quantitative analysis;
- the ability to forecast the dynamic spatio-temporal interactions of the local urban systems;
- the ability to manage large volumes of information; and
- technical competence in the use of SA tools, which are often designed based on complex theories (Kapelan et al. 2005).

The respondents were asked to give their views on human factors contributing to the non-adoption of tools in the context of sustainability assessment. The responses pointed toward the fact that the potential of applications of SA tools has not been sufficiently understood because of the lack of a comprehensive knowledge of the complexities surrounding strategic sustainability and the absence of clear guidelines to carry out the assessments. This is often compounded by the lack of in-house expertise to perform sustainability assessments.

Around one third of the local authorities surveyed in this research stated that they either fully or partially rely on external consultants to perform sustainability assessment on behalf of the respective organisation because of the lack of relevant in-house expertise. This practice will perpetuate the lack of development of in-house expertise.

A survey conducted by the Local Government Association reported that 80 per cent of the local planning authorities (LPAs) in the UK had experienced difficulty in delivering effective planning services in the previous 12 months due to skill shortage, especially in the strategic planning (PP 2004). Previous reviews, most notably by Sir John Egan (2004) have also highlighted the lack of skilled professionals to this effect. Uncertainty regarding the type of skills and knowledge required by the practitioners often hinders the adoption of tools in strategic planning.

Fragmentation is another key barrier to the successful implementation of sustainability assessment in strategic planning. Most public and private organisations encouraged employees to be specialised in specific subject areas and often group them together in various geographical locations (Moobela et al. 2007), which has created fragmentation and compartmentalisation of knowledge and skills. This is most visible in local governments with little collaboration among departmental groups, as observed in a local government authority. Sustainability assessment was sub-tasked through various departments; e.g. housing, transport, environment, social and demographic, retail and economic. The delegation of an integrated task to various independent departments impeded the overall efficiency of the assessment process. However, fragmentation is common in large multi-disciplinary projects/assessments in other fields, which demonstrate similar challenges relating to the efficiency of the tasks undertaken (Garnett and Kouzmin 1997).

Lack of corporate commitment and resistance to change were also identified as barriers. Communication gaps that may exist within an organisation or between the client and the consultant are also found to hinder the effective implementation of SA tools. Poor communication between tool users and the policy makers are found to have the same effect. One of the consultants interviewed reported that on some occasions additional efforts were needed to convince clients of the potential of applications of sustainability assessment tools in solving existing urban problems. Lack of client interest may also discourage the external consultants from using the tools.

4.3 Barriers associated with resources

More than half of the respondents cited that inadequate funding to support the adoption of SA tools was one of the most tangible barriers associated with resources. Especially in the private sector, the allocation of funding for SA tools is often weighted against the immediate financial gain of the organisation that may result from the use of the tool. In most organisations, internal and/or external persuasion is needed to fund adoption of new methods, even in the case where potential benefits are fully understood.

The application of a specific tool can be limited by the availability of the required data, usually defined in specific formats. Lack of interoperability, resulting from disparate underlying information models of data, often restricts the adoption of innovative tools. It has been observed that users prefer to use techniques that consume readily available data without pre-processing. Lack of time to become trained as a proficient user and to acquire new knowledge, often required in the context of SA, has also been reported as one of the barriers.

5 Conclusion

The findings reveal that lack of appropriate tools to satisfy the demands of the sustainability assessment process and the lack of required expertise are the major barriers to the adoption of SA tools in practice. In the complex platform of decision-making, the adoption of tools is often constrained by the chain effects of interrelated barriers. Emerging policy context calls for robust and integrated tools that will perform efficiently to guide the decision-making process. Joined-up efforts from industry and academia are needed to enhance the robustness of the SA tools, which needs to be designed as resource efficient, user-friendly, adaptive, innovative, communicative and interactive. Local and national initiatives are needed to overcome the barriers faced by the practitioners. With regard to the shortage of relevant professional expertise and a lack of comprehensive knowledge and technical skills to carry out sustainability assessment, research in strategic planning needs to look at the context at which sustainability assessment tools are developed and applied.

Sustainability assessment is a complex and resource intensive process. It is evident that the main reason behind conducting the sustainability assessment during strategic planning is statutory requirements. In the current context the potential benefits of this relatively new practice to aid the decision-making process are not fully understood, which also affect the adoption of tools. The desired goals of sustainability assessments can only be achieved when the local leadership is convinced of its usefulness and the local planning authorities are motivated, trained and supported with necessary resources.

6 Acknowledgement

The authors gratefully acknowledge the financial support of the UK's EPSRC Sustainable Urban Environment programme.

7 References

Barrett, J, Wiedmann, T and Ravetz, J (2005) Development of physical accounts for the UK and evaluating policy scenarios, Stockholm Environment Institute.

BRE (2006) BREEAM (BRE Environmental Assessment Method). Watford: Building Research Establishment. Available from: http://www.breeam.org.

Brownhill, D and Rao, S (2002) A sustainability checklist for developments: a common framework for developers and local authorities. Watford: BREPress.

Brown, D, Dillard, J and Marshall, R S (2006) Triple Bottom Line: A business metaphor for a social construct. Barcelona: Universitat Autònoma de Barcelona

DCLG (2004) Planning Policy Statement 12: Local Development Frameworks.

DCLG (2005) Sustainability Appraisal of Regional Spatial Strategies and Local Development Documents: Guidance for Regional Planning Bodies and Local Planning Authorities. London: Department for Communities and Local Government.

DEFRA (1999) A Better Quality of Life: A Strategy for Sustainable Development for the UK. London: Department for Environment, Food and Rural Affairs.

DETR (1999) A better quality of life - strategy for sustainable development for the United Kingdom. London: Department for the Environment, Transport and Regions.

Egan, J (2004) The Egan Review: Skills for Sustainable Communities. London: Office of the Deputy Prime Minister.

Elwood, S A (2002) GIS use in community planning: a multidimensional analysis of empowerment. "Environment and Planning A", 34(5), 905-22.

ESCTC (2001) Charter of European Cities and Towns Towards Sustainability (the Aalborg Charter). Brussels: The European Sustainable Cities & Towns Campaign.

Goelman, A (2005) Technology in context: mediating factors in the utilization of planning technologies. "Environment and Planning A", 37(5), 895-907.

Holden, M (2000) GIS in democratic and sustainable land use planning: Lessons from critical theory and the Gulf Islands. "Journal of Planning Education and Research", 19(3), 287-96.

Hopkins, L D (1999) Structure of a planning support system for urban development. "Environment and Planning B: Planning and Design", 26(3), 333-43.

HMSO (2005) Securing the future: delivering UK sustainable development strategy. Norwich: Her Majesty's Stationery Office.

Hurley L, Ashley R and Mounce, S (2008) Addressing practical problems in sustainability assessment frameworks. "Engineering Sustainability", 161, 23-30.

Innes, J E (1990) Knowledge and Public Policy: The Search for Meaningful Indicators. New Brunswick: Transaction Publishers.

Innes, J E and Booher, D E (2000) Indicators for sustainable communities: a strategy building on complexity theory and distributed intelligence. "Planning Theory and Practice", 1(2), 173-86.

Kapelan, Z, Savic, D A and Walters, G A (2005) Decision-support tools for sustainable urban development. "Journal of Engineering Sustainability". 158, 135-42.

Moobela, C, Price, A D F and Taylor, P J (2006) The case for social capital in the quest for holistic sustainability assessment, "1st International Conference on Sustainability Measurement and Modelling", 16-17 November 2006, Terrassa, Spain.

Moobela, C, Price, A D F and Bristow, A L (2007) Surfing the landscape of barriers and incentives to sustainability assessment in an urban development context. In: Horner, M, Hardcastle, A, Price, A and Bebbington, J (Eds.), "International Conference on Whole Life Urban Sustainability and its Assessment", 27-29 June 2007, Glasgow.

Mustapha, S M F D S and Sayed, B T (2006) Towards Designing the Info-structure for Developing Socio-technical Knowledge Management System (KMS). In: International Conference on Knowledge Management (ICKM) 2005, 7-9 July 2005, Kuala Lumpur.

OPSI (2004) Planning and Compulsory Purchase Act 2004. London: Office of Public Sector Information.

PP (2009) Planning Portal in a Nutshell: The Planning Skills Crisis, Planning Portal. Web: http://www. planningportal.gov.uk/england/professionals/en/1107538610217.html,

Rotmans, J (2006) Tools for Integrated Sustainability Assessment: A two-track approach. "The Integrated Assessment Journal", 6(4), 35-57.

Watson, P, Jones, D and Mitchell, P (2005) Sustainability Measures for Decision-Support: Redefining Life Cycle for a Building Sustainability Assessment Framework. In: "4th Australian Life Cycle Assessment Conference", 23-25 February 2005, Sydney, 1-12.

Wilkinson, S J and Reed, R G (2007) The Structural and Behaviourial Barriers to Sustainable Real Estate Development. "American Real Estate Society (ARES) Conference", 11-14 April 2007, San Francisco, USA.

Zellner, M L, Theis, T L, Karunanithi, A T, Garmestani, A S and Cabezas, H (2008) A new framework for urban sustainability assessments: Linking complexity, information and policy. “Computers, Environment and Urban Systems”, 32(6), 474-488.

Faecal sludge (FS) emptying and transport: a sustainable link in urban on-plot sanitation management

Andrews Nkansah

Loughborough University, UK

On-plot sanitation is dominant form of sanitation in the cities of low-income countries, especially Africa and Asia. On-plot sanitation involves a chain of services that include infrastructural provision; pit or pan emptying; sludge transport; and final disposal, treatment or reuse of sludge. But so far there has been exclusive reliance on market for the latrine infrastructure to the exclusion of the other segments of the chain of associated on-plot services such as faecal sludge emptying, transport and safe disposal from the on-plot latrines. Thus, whereas more efforts have been geared towards infrastructural establishment of on-plot sanitation in an attempt to meet the MDG, very little has been done regarding the sustainable service links without which on-plot latrines in the urban spaces will cease to function at some point in time. A comprehensive review of the literature points to the fact that urban faecal sludge emptying and transport has either been completely neglected or poorly managed in many low–income countries where the on-plot latrines dominate the cities' sanitation system. This neglect and lack of appropriate management framework and capacity to manage faecal sludge emptying and transport successfully has resulted in health and environmental pollution problems in many urban areas in the low-income countries. Some of the key problems frequently mentioned are:

- Bucket and pit latrines fill up and overflow without being emptied.
- Lack of appropriate equipment and expertise for the job resulting in environmental and aesthetic mess.
- Constant breakdown of emptying and transport machines with little or no chance for repair or replacement due to lack of funds and availability of spare parts.
- Appropriate policy for emptying and transport is non-existent.
- Poor settlement and infrastructural siting which hamper or deny vehicular access, and unnecessarily increase costs to the users..
- Households' have poor knowledge and attitude towards latrine use and faecal sludge management which have created emptying and transport operational problems.
- The poor in the urban areas do not only suffer from the worst form of sanitation but also from the highest frequency of emptying and payment due to relatively higher usage rate for relatively small latrine volumes.

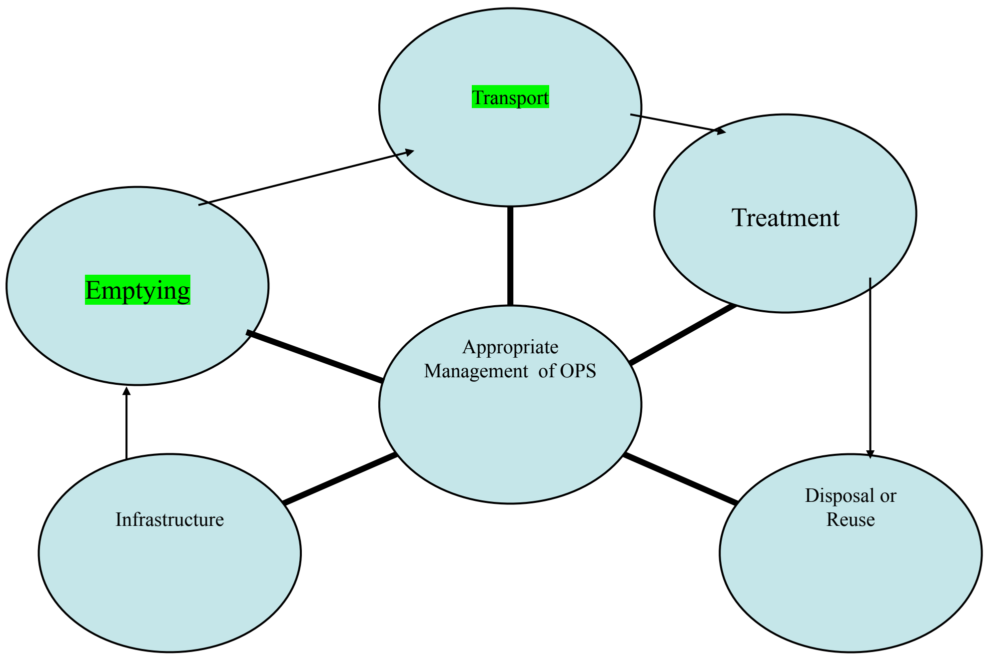
The implications of these problems are that the mere establishment of on-plot latrines does not guarantee total sanitation unless the pits, pans, tanks and vaults associated with the on-plot systems are regularly and properly emptied. This paper therefore explains the problems facing urban faecal sludge emptying and transport in the low-income countries, and offer suggestions as to what necessary actions ought to be taken in order to .address the problems in the low-income countries.

Keywords: low-income countries, on-plot sanitation, sustainable link, urban faecal sludge emptying and transport

Introduction

On-plot sanitation facilities are the predominant form of urban excreta disposal for the majority of urban dwellers in Africa, Asia and other parts of the developing world (Saywell, 2000; Strauss et al., 2000; SDC, 2004). Several reasons have been ascribed to this: lack of water, adequate funds, expertise(technical and managerial) as well as relative ease of putting up the on-plot infrastructure individually without major governmental interventions as found in conventional reticulated sewerage systems (Black and Fawcett, 2008; Mara and Alabaster, 2008). However, the mere completion and use of on-plot latrine infrastructure does not necessarily complete the urban sanitation management chain unless it is accompanied by other essential services. Thus, in order to make the urban on-plot sanitation in the low-income countries sustainable, important services such as excreta emptying, transport, treatment, reuse, and disposal ought to be carried out as well (see figure 1 below).

Figure1: On-plot sanitation chain of services



Source: Nkansah, 2008

Critical to the chain of the services in figure 1 above are pit and bucket emptying and transport to disposal points of safety. Unfortunately, reports on these critically important services are appalling as shit-filled pits and buckets overflow their brims and are either not emptied or poorly emptied and handled (Van der Geest, 2002; Pandey and Kaul, 2000; Chaggu et al 2002; Chaggu 2004).

The problems

As mentioned in the introduction, pit emptying has been a problem in many urban communities in the developing countries in spite of its sustainability role in the urban on-plot sanitation system. The literature surveyed pinpoints the following key problem areas of emptying and transport of human excreta that are worth considering:

1) Indiscriminate dumping with attendant health and environmental implications

Emptied and untreated excreta are frequently discharged into the environment haphazardly, causing environmental pollution and serious health effects (Ingallinella et al 2002; Montangero et al, 2002; Strauss and Montangero, 2002; Parkinson and Tayler 2003). Some of these health effects include diarrhoea (Jinadu *et al,* 2004; Stanton and Clemens, 1987; Han and Moe, 1990); transmission of helminth infections that could impede growth and cognitive development of children (Khanom and Leornard 1989; Nokes *et al,* 1992; Esrey, 1996). incidence of ascariasis (roundworms); Trichuris (whipworm); and Ancylostomiasis/Necator (hookworm) which affects millions of lives both adults and children across the globe (Norhayati, 2003). The cause of the indiscriminate dumping has been ascribed to lack of appropriate dumping sites; very long distance to the dumping sites difficult to be reached by faecal sludge transporters; and lack of proper city planning that impede accessibility of mechanised emptying and transport tankers (Ingellinella *et al*, 2002).

2)Lack of appropriate emptying policy for emptying and transport

Appropriate policy governing urban faecal sludge emptying and transport is non-existent (Jones 2005; Chaggu et al 2002, Klingel *et al*, 2002;). This is worrying since lack of sanitation policy hugely constrains the improvement as well as coverage of sanitation in the developing countries (Seppälä, 2002; Elledge *et al*, 2002 Cotton *et* *al*, 2003; Tayler and Scott , 2005; DFID, 1998). The few sanitation policies drawn for many developing countries are unclear, poor and fragmented (Tayler and Scott , 2005), even though experts have come out with various views on how to get the policies drawn and implemented.

Elledge *et al* (2002) stipulates that sanitation policy should entail a set of procedures, rules and allocation of mechanisms that provide the basis for programmes and services. Cotton et al (2003:13) and Tayler *et al* (2003:48), on the other hand, believe that the sanitation policy should extend beyond mere display of the policy documentation to include the attitudes and assumptions of those who are responsible for developing the policy and its supporting instruments. What is lacking in these assertions is the inclusion of the users' concerns and views. Yet, users are mainly responsible for the management of their excreta especially in the households. Therefore, their views should be well articulated in any faecal sludge management policy. This position is agreed by Samanta and Van Wijk's (1998) when they stated that any sanitation technology adopted in sanitation policy should match users' own frames of reference that address both general and specific sanitation issues peculiar to the users' environment. In the other words, the policy for emptying and transport of urban faecal sludge should be all inclusive involving both rich and the poor in order to solve urban sanitation problems better (DFID, 1998; Kalbermatten Associates, 1999).

Therefore in order that the emptying and transport policy will be effective, the policy process should involve views of key faecal sludge management stakeholders which, depending on the urban area, could include households as well as representatives from the communities, traditional authorities, emptiers, transporters, relevant government authorities and experts. At the end of the day, what is important is that any policy put in place should not only be realistic but also take account of all relevant stakeholders (Tayler and Scott, 2005).

3)Risks posed by manual emptying

Literature points to three principal emptying systems for FS which are done according to the type and contents of the latrine (Mara, 1996; Chaggu *et al*, 2002; Van der Geest, 2002; Bosch and Schertenleib, 1985). These are :

- Hauled pan or bucket systems where the pans or buckets used for FS storage are either emptied there and then into another bucket to be hauled or the same bucket is hauled to the disposal or transfer sites (i.e. holding tanks), emptied and either returned to their original location (i.e. set-out set-back mode) or some other location.
- Digging or scooping such that the FS is removed with simple manual hand tools ; and
- Siphoning under vacuum and pneumatic forces, where a tanker is used to suck the FS from vaults, pits or septic tanks through automated or manually operated means.

The last point is usually comprised of automated mechanical emptying of latrines, with the use of vacuum or pneumatic pressure of varying sizes to desludge or empty the pits (Mara, 1996; Bosch and Schertenleib, 1985). However, where accumulation of FS has occurred at the bottom of pits, only specialised and expensive tankers may be able to empty the FS (Mara, 996). Unfortunately such expensive emptying equipment may either be beyond the affordability of many emptiers, or inaccessible to pits in the cities of the low-income countries. These factors combined with constant mechanical breakdowns; lack of funds, expertise and spare parts to repair (Bosch and Schertenleib, 1985; Montagero *et al*, 2002) have inevitably resulted in the dominance of manual emptying over mechanical emptying in many places, especially with regard to simple pit and pour-flush latrines (Pickford and Shaw, 2002) even though manual emptying of pits is known to be less effective than the mechanical emptying (Mara, 1996; Chaggu *et al*, 2002; Van der Geest, 2002).

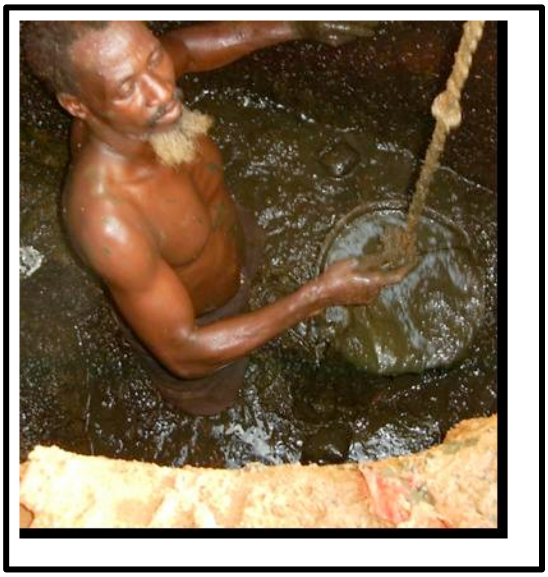
Apart from the conventional mechanised means such as the large vacuum tankers, other appropriate technology types (e.g. MAPET, Vacutug and Gulper) have been designed and built to suit local conditions and latrine types. Some of these can be operated either purely manually (Gulper), mechanically or manual-mechanically (MAPET). Pure manual emptying technologies in the low-income countries vary and include hand tools and accoutrements such as hand-operated pumps, bare or gloved hands, broom, buckets, drums, scoopers, pick axe, spade, ladder, ropes, and boots (Debomy, 2000; Kone, 2008). For example, Debomy (2000) states that in Kano, Nigeria, manual pit emptying entails the following procedure and tools:

- Diggers or hoes for excavating hardened excreta.

- Shovels for removing the excreta and putting it into containers.
- Buckets for conveying the excreta out of the household where a hand truck cannot enter.
- A long wooden stick for measuring the depth of the latrine (for determining cost for emptying)
- Small hand truck for conveying the excreta to the dumping site.
- Kerosene and ash used in controlling odour.

These tools are selectively used by manual operators to suit latrine and sludge types (liquid, solid or semi-solid). Manual operators in the form of small teams have used hand-operated pumps to siphon sludge and fill them into drums for onward transfer to disposal sites (Pickford and Shaw, 2002; Strauss and Montagero, undated). In Burkina Faso and elsewhere, emptiers have been found to immerse themselves in the sludge filled-pit in order to get the sludge emptied (See picture 1 below). This creates mess and inevitably allow some excreta to spill around the base of the bucket or pit latrines and the streets with increased exposure to human faeces; breeding media for harmful bacteria and vectors such as Musca sorbens, insects and pathogens which can attack the households (Muller, 1997; Emerson *et al*, 2000, 2001; Chaggu *et al*, 2002; Van Der Geest, 2002).

Picture 1: Manual emptier in Burkina Fasso immersed in faecal matter to get it emptied



Source: Kone, 2008.

In some situations, manual emptiers who cannot withstand the stench and nastiness of the human excreta result in the use of chemicals like paraffin to control the odour and strong alcoholic drinks to help overcome the stench psychologically (Debomy, 2000). This could lead to possible environmental pollution and alcoholic addiction.

4)Ignorance and attitudinal problems

The Millennium Project Task Force on Water and Sanitation acknowledges that in some of the low-income countries, knowledge and understanding among policymakers about technical issues and the importance of sanitation is found lacking (Lenton *et a*l, 2005). This institutional knowledge gap combined with users' poor knowledge and attitude to latrine use, including materials dumped into the pits, compound the problems of emptying in terms of cost, equipment and method (Nkansah, 2008). Research conducted by Tiberghien (2002) in Mexico does confirm that any choice of safe excreta disposal systems that do not reflect people's knowledge, perception and culture will not be sustainable. His research showed that authorities in a school in El Mirador, Mexico, regarded flush toilets and cistern toilet-sewer system as the only appropriate sanitation technology and therefore failed to consider other more appropriate alternatives such as dry sanitation or ventilated pit latrines given the lack of water supply in the school. He also cited an attitudinal problem in San Luis Beltran community, in Mexico, where the perception that ecological toilets were meant for the poor did not encourage the people to use it. In another development, in El Savador , it was found out that women would not use the communal latrines designed by the engineers, because the toilet had been designed with a gap at the bottom of the door which exposed their feet and thus offended notions of privacy (Moser, 1989).

The implications drawn from the above analysis is that, if sanitation programmes, such as faecal sludge emptying and transport, are to be successful among users, then their perceptions and needs should be well understood and considered in any sanitation intervention that involves them (Saywell, 2000, Kalbermatten Associates, 1999). This view point is supported by the South Africa Water Services Act (undated) which states that effective sanitation should not only focus on infrastructure but also on people and their behavior. The implication from this is that sanitation is an area in which one may sometimes have to counter superstitions and traditional beliefs which are in contradiction to what one is attempting to teach. This could be a dilemma that face practitioners. However, with appropriate educational and sensitization measures, fundamental changes which contrasts traditions could be achieved in such a way that the socio-cultural factors and customs may not compromise efforts to promote sanitation in order to control diseases (Sattenspiel, 2000).

5) Poor Planning and Settlement pattern

Poor planning and settlement pattern hamper or deny vehicular access; and prolong transport distance and time. This unnecessarily increases costs to the users (Ingallinella *et al*, 2002). Transporting FS within cities in the low-income countries have been done mainly manually and mechanically. Manual transport of FS is by means of carrying bucket, pans or baskets on head or shoulders and pulling of cart by men or animals (Hurtado 2005, Van der Geest, 2002; Gupta, 1997), while mechanical means is by vacuum tankers, trucks, tractors and all forms of motored carts (Mara, 1996; Bosch and Scertenleib, 1985).

Route layout in the master plan of a city enables flow of traffic goods and humans. Therefore, once the city is unplanned, it leaves little or no room for appropriate transport of goods and services such as urban FS transport. Lack of sufficient routes in the city meant for traffic could lead to transporting FS in the midst of traffic jams which together with long haulage distance has been found to bring about high fuel consumption and transport costs; indiscriminate dumping; environmental pollution and aesthetic nuisance (Montagero et al, 2002; Ingellinella et al, 2002).

In environments where the streets are too narrow for large vacuum tankers to apply, it is the relatively small intermediate technologies that perform better. Due to their relatively small volumes, it is sometimes more economical to empty their contents into transfer points or a bigger container for onward transport to final disposal sites which are often distant from the city centre (Tchobanagolous et al, 1993). A good example is in Nairobi, Kenya, where a community has adopted the idea of using the sewer mains as sludge transfer stations served with the Vacutug system (Luthi, 2008). In some instances the large vacuum tankers also solve the long haulage problem by discharging their contents into the sewer mains (Schaub-Jones *et al*, 2006). However, in a situation where the manual means of transport or the intermediate technologies could not carry their contents far enough to safe disposal points, indiscriminate dumping could occur in the community. This could be especially so when long haulage distance and traffic jam is involved that could contribute to high transport costs (Ingellinella *et al*, 2002; Montagero *et al* 2002). However, with careful and diligent planning, these problems could be addressed through systems such as localised community based holding tanks, treatment sites and reuse possibilities (GHK, 2002; EAWAG, 2005; Parkinson and Taylor, 2003). Alternatively, transport times could be arranged in such a way as to avoid peak times of the day.

6)Fragmentation in demands for emptying of latrines

When it comes down to household level of sanitation, there are several perceived factors that contribute to the cost of FS emptying and transport. These are types of latrine technologies; means of emptying the pit; pit re-emptying frequency; differences in pit sizes; user numbers per pit; pit filling-up rates and times at different locations. These variables contribute to fragmentation in demands for pit emptying and economy of scale problems (Schaub-Jones, 2006). Ideally, to benefit from economy of scale, it would be economically expedient for emptiers and users to aggregate their demands for emptying and transport of FS.

It is important to note that fragmentation in demand of FS emptying per se does not imply that the overall FS generation in a city ready for daily collection is by any means small. For instance, a city of Kumasi in Ghana with over 1 million inhabitants, daily generate 500m3 of faecal sludge (FS) collected from on-site sanitation systems (Mensah, Cofie and montangero, 2003). With average conventional vacuum tanker size of about 5m3 in the city (Vodounhessi and von Munch, 2006), it will take about 100 vacuum tanker operations in a day to do the job of FS emptying and transport. The sheer scale of such an emptying operation overcomes the economy of scale problems. What is challenging though is how to coordinate and monitor all the emptying and transport service operations. This implies that the demand problem due to fragmentation will, among other things, depend on the population of users in a community in terms of density, settlement pattern and the latrine types and sizes used. Therefore, in communities with relatively low population density and dispersed latrine distribution, reducing the size of the latrine vaults or pits is a sure way of increasing the frequency of emptying and promoting the economy of scale (Boot, 2007). It is therefore recommendable that in a situation of dispersed settlement with relatively less user density, pit sizes can purposefully be constructed to:

- reduce cost of construction,
- reduce sludge consolidation and thickening and, thus, increase frequency of emptying (Boot, 2007; SANDEC/EAWAG, 2006); and
- create economy of scale (Boot, 2007; Schaub-Jones, 2006)

Actions Needed

From the problems listed above, what is required is concerted effort in planning and management framework that could deliver sustainable emptying and transport of faecal sludge (FS) from urban pits in the low-income countries. To do this successfully, there is the need to understand urban household on-plot latrines from viewpoints of policy, planning, construction, function, education, use and management of both the infrastructure and the contents therein. These issues are explained into details below:

- Policy:- There is the need for sound urban on-plot sanitation policy to specify building codes; define rules and regulations that will streamline and harmonise latrine technologies and emptying requirements as well as punish malfeasance.
- Planning for latrine construction and management:- When going for a particular on-plot latrine of choice the issues that should come to mind are: cost., technology, type, use, space and emptying requirements. Since emptying and transport of the sludge is required, how and where to place the pits in relation to the accessibility and reach of the emptying equipment is of paramount importance.

- Construction:- How and what materials are used for construction of both the sub- and super-structure need serious consideration as these will affect costs, use, convenience, security, structural stability and emptying requirements.

- Function:- Acceptability and sustainability of on-plot latrine depends on its successful workability according to design and intended results.
- Education:- There is the need to educate and train latrine builders to construct good latrines that will suit the geographical location (in terms of soil characteristics and accessibility), use and emptying requirements. Users should also be educated to understand the implications of their actions in terms of choice of latrine, use and emptying and transport requirements.
- Use:- The way users use latrine will impact greatly on its function and sustainability. For example, a double pit latrine meant for alternate use has been found to be used concurrently by users (Cotton *et al*, 1995), thereby jeopardising the objectives for which it was made. Anal cleansing materials used and where they are placed after use, as well as materials dropped into the latrines should be a matter of concern. This is because bulky materials dropped in the pits can interfere with pit emptying equipment and personnel (Nkansah, 2008) (See picture 2 below).

Picture 2: Bulky and inappropriate materials dropped into the pits that can interfere with emptying

Source: Author's field work, 2007

- Management:- Since reticulated sewerage system naturally links up households and connects their sewers into centralised treatment or disposal point, utilities do not find it as much difficult to monitor and manage the system as in on-plot system. This is because on-plot sanitation system is fragmented both in terms of infrastructure and services. This, according to Schaub-Jones (2006), leads to diseconomy of scale of the emptying operations which might affect sustainability of the on-plot system in a community. After emptying the contents of household latrines, the sludge or faecal matter has to reside within or transported across the community for disposal or treatment and or reuse. Depending on mode of emptying and transport and destination points of disposal, the whole community could be at risk once pit or pan emptying has occurred. Thus, effective emptying and sludge transport should not be the sole responsibility of the household but that of the whole community at large. The overall management of the on-plot facility and the associated services, starting from periodic cleaning of the latrine and its environments to infrastructural maintenance and pit emptying as well as successful transport to safety are necessary. This implies the need to adopt comprehensive management approach that will understand the problems at stake and involve the key stakeholders to tackle the problems. It also implies streamlining and harmonising latrine technologies as well as the emptying and transport requirements. Since safe disposal of urine and faeces as well as the protection of the environment are the collective responsibility of all, there is the need to institute a more effective faecal sludge management system in the cities of the low-income countries. Mara and Alabaster (2008) and EAWAG (2005) have suggested community-based and responsive management paradigms, such as the Household Centred Environmental Sanitation Approach, which are sensitive to the households' plights and interests. By so doing, urban FS emptying and transport could be effectively taken care of as sustainable link to urban sanitation services in the low-income countries.

Conclusion

On-plot sanitation though relatively cheap and acceptable to the urban communities in the low-income countries require emptying and transport of its faecal sludge in order to function sustainably. Since means and frequency of emptying (mechanical or manual) are linked to the type of latrine put up and use, implementation of on-plot sanitation infrastructure should take not only the households interests into consideration but also the interests of the community at large. This implies urban sanitation policy makers and other stakeholders should take into consideration the variability in technology, use and associated emptying requirements; and factor these into policy, planning and budget allocations. Failure to do this could jeopardise on-plot facility as a viable and sustainable alternative for urban sanitation in the low-income countries. Therefore the management of on-plot sanitation in the urban areas of low-income countries should tackle the problems right from the roots to include the socio-cultural and demand concerns of the households and the communities at large. Part of the management strategy is to collate information on all available emptying and transport technologies that has hitherto been scattered, disorganised and informal so that the emptiers and transporters will have the opportunity to access their preferred choices. This can improve emptying and transport services of urban FS and reduce incidence of diseases, environmental pollution and aesthetic mess that beset urban FS management in many urban spaces where on-plot sanitation is the norm.

References:

Black, M and Fawcett, B. (2008). The Last taboo. Opening the Door on the Global Sanitation Crisis. Earthscan, London, UK.

Boot, L.D. (2007). TALKING CRAP: FAECAL SLUDGE MANAGEMENT IN ACCRA, GHANA. A research report submitted in partial fulfilment of the requirements for the award of degree of Master of Science of Loughborough University. Loughborough, UK.

Bosch, A. and Schertenleib, R.(1985). *Emptying On-Site Excreta Disposal System: Field Tests with Mechanized Equipment in Gaborone (Botswana).* Switzerland: International Reference Centre for Waste Disposal (IRCWD).

Chaggu, E. J. (2004). Sustainable Environmental Protection Using Modified Pit-Latrines. Ph.D Thesis, Wageningen University, The Netherlands.

Chaggu, S., Mashauri, D., Van Buuren, J., Sanders, W., Lettinga, G. (2002) Excreta Disaposal in Dar-es-Salaam. Environmental management journal, Volume 30, No.5 pp609-620, Nov. 2002.

Cotton, A., Franceys, R., Pickford, J., and Saywell, D.(1995). On-plot sanitation in low-income urban communities. A review of literature. WEDC, Loughborough university, UK.

Cotton, A.P., Tayler, K., Obika, A., Scott, R.(2003) Application of Tools to support National Sanitation Policies. Inception Report. WEDC, UK.

Debomy, S.(2000). *Commercial Solid Waste Collection by Night-soil attendants in Kano, Nigeria*. Water utilities Partnership Project 5. 2000

DFID(1998). Guidance manual on water supply and sanitation programmes, DFID, UK.

Eawag (2005). Household-Centred Environmental Sanitation: Implementing the Bellagio Principles in Urban Environmental Sanitation (Provisional Guideline for Decision-makers). Eawag (Swiss Federal Institute of Aquatic Science and Technology), Duebendorf, Switzerland.

Elledge, M.F.(2003). *Sanitation Policies.* Thematic Overview Paper, reviewed by Schertenleib, R, IRC International Water and Sanitation Centre, The Netherlands.

Emerson, P.M., Bailey, B.L., Mahdi, O.S., Walraven, G.E.L. and Lindsay S.W. (2000). Transmission ecology of the fly Musca sorbens, a putative vector of trachoma. *Transactions of the Royal Society of Tropical Medicine and Hygiene* **94,** 28–32.

Emerson, P.M., Bailey, R.L., Walraven, G.E.L. and Lindsay, S.W. (2001) Human and other faeces as breeding media of the trachoma vector Musca sorbens. *Medical Veterinary Entomology,* **15**, 314–320.

Esrey, S., A.(1996) Water, Waste and Well-being: a Multicountry Study, Vol. 143, No.6, pp. 608-623, American Journal of Epidemiology

GHK(2002). *Effective Strategic Planning For Urban Sanitation Services: Fundamentals of Good Practice*. GHK, Research & Training Ltd, UK.

Gupta, K.N.(1997). Scavengers and Scavenging in India: A Case Illustration of Ghaziabad. In Muller, M.S.(ed)(1997). *The collection of household excreta. The operation of services in urban low-income neighbourhoods. Urban Waste series 6*

Han, A.M. and Moe, K. (1990) Household faecal contamination and diarrhoea risk. *Journal of Tropical Medicine and Hygiene* 93, 333–336.

Hurtado, D.(2005). *Compost Latrines in Rural Panama: Design, Construction and Evaluation of Pathogen Removal.* A report submitted in partial fulfillment of the requirements for the degree of Master of science in Environmental Engineering, Michigan Technological University.

Ingallinella A.M., G. Sanguinetti, T. Koottatep, A. Montangero and M. Strauss(2002) The challenge of faecal sludge management in urban areas – strategies, regulations and treatment options. Water Science and Technology Vol. 46 No 10 pp 285–294 © IWA Publishing 2002.

Jinadu, M.K., Esmai, O.A., Adegbenro, C.A.(2004) Disposal of children's faeces and implications for the control of childhood diarrhoea. Journal of The Royal Society for the Promotion of Health Volume 124, Issue 6, November 2004, Pages 276-279.

Jones, D.(2005) Why traditional approaches to on-site sanitation provision are failing poor households. 31st WEDC International Conference, on MAXIMIZING THE BENEFITS FROM WATER AND ENVIRONMENTAL SANITATION Kampala, Uganda, 2005

Kalbermatten Associates, Inc. (1999). *Study to Identify Gaps, issues, and Constraints in Urban Environmental Sanitation.* Report No1: Preliminary Identification of Gaps. Washington D.C., U.S.A.

Khanon, K. and Leornard, R.C.(1989). A hygiene experiment in rural Bangladesh. *Sociol Perspect, Summer*;32(2):245-55

Klingel, F., Montangero,A.,Koné,D.,Strauss, M(2002). Faecal Sludge Management in Developing Countries: A planning manual. 1st Draft, April 2002. Swiss Federal Institute for Environmental Science and Technology Department for Water and Sanitation in Developing Countries.

Kone, D. (2008). Personal communication. EAWAG/SANDEC, Switzerland.

Lenton, R., Wright, A.M., Lewis, K.(2005). Health, dignity, and development: what will it take? UN Millennium Project Task Force on Water and Sanitation 2005. Earth Scan, London, UK.

Luthi, (2008). Personal communication about HCES approach for FS transport in cities of developing countries. SANDEC/EAWAG, Switzerland

Mara, D(1996) Low-Cost Urban Sanitation. John Wiley and sons, Chichester, UK

Mara, S. and Alabaster, (2008). A new paradigm for low-cost urban water supplies and sanitation in developing countries. Water Policy 10 (2008) 119–129

Mensah, A.Cofie, O., Montangero, A.(2003). *Lessons from a pilot co-composting Plant in Kumasi, Ghana.* 29th WEDC international conference on 'Towards Millennium Development Goals', Abuja, Nigeria, 2003.

Mertens, T.E, Jaffar, S., Fernando, M.A, ,Cousens, S,N and Feachem, R.G. (1992). Excreta disposal and latrine ownership in relation to childhood diarrhoea in Sri Lanka. *International Journal of Epidemiology* 21, 1157–1164.

Montangero, A., Koné, D., Strauss, M. (2002). Planning Towards Improved Excreta Management. In: *Proceedings, 5th IWA Conference on Small Water and Wastewater Treatment Systems*, Istanbul, Turkey, Sept. 24-26.

Moser, C.O.N. (1989). ' Gender Planning in the Third World: Meeting Practical and Strategic Gender Needs'. *World Development* , Vol17 No.11, p1807.

Muller M. S.(ed)(1997)The collection of household excreta : the operation C65 of services in urban low income neighbourhoods . Urban waste series 6; WASTE and NSIC/AIT ISBN: 974-8256-77-4. 73p

Nkansah, A. (2008). *Appropriate emptying and transport management of faecal sludge in the urban areas of Low-income countries.* On-going PhD research at the WEDC, Department of Civil and Building Engineering. The university of Loughborough, Loughborough, The UK.

Nokes, C., Grantham-McGregor, S.M., Sawyer, A.W., Cooper, E.S., Robinson, B.A. and Bundy, D.A.P. (1992) Moderate to heavy infections of Trichuris trichiura affect cognitive function in Jamaican school children. *Parasitology,* 104: 539-547.

Norhayati, M., Fatmah, M.S., Yusof, S. and Edariah, A.B.(2003). Intestinal parasitic infections in man: a review. *Med J Malaysia.* 2003 Jun;58(2):296-305

Pandey, R.A., Kaul, S.N.(2000). Status of domestic wastewater management in relation to drinking-water supply in two states of India. *Schriftenreihe des Vereins fur Wasser-, Boden- und Lufthygiene* **Volume 105**, 2000, Pages 405-411.

Parkinson, J.and Tayler, K.(2003)Decentralized wastewater management in peri-urban areas in low-income countries. *Environment and urbanization* **Vol.15** No.1 April 2003

Pickford, J. and Shaw, R. (2002). 'Emptying pit latrines'. In: *Waterlines,* **vol. 23**, no. 3, p. 15-18.

Samanta, B.B. And Van Wijk, C.A.(1998). Criteria for Successful Sanitation Programmes in Low Income Countries. *Health Policy and Planning*; **13**(1): 78-86.

SANDEC/EAWAG (2006). URBAN EXCRETA MANAGEMENT - SITUATION, CHALLENGES, AND PROMISING SOLUTIONS. Symposium and Workshop on the 1st International Faecal Sludge Management Policy. Dakar , Senegal.

Sattenspiel, L.(2000). Tropical environments, human activities, and the transmission of infectious diseases. *Yearbook of Physical Anthropology* **43**:3-31. Department of Anthropology, University of Missouri, Columbia. MO 65211, United States.

Saywell, D(2000)User Based Perceptions of on-plot sanitation systems in low-income urban communities in Africa and Asia. PhD thesis at WEDC, Dept. of Civil and Building Engineering, University of Loughborough, Loughborough, UK.

Schaub-Jones, D(2006). Sanitation partnerships: Can Partnership make a difference to urban sanitation challenge? Building partnerships for Development in Water and Sanitation(BPD), London, UK.

Schaub-Jones, D., Eales, K. and Tyers, L. (2006). Sanitation Partnerships: Harnessing their potential for urban on-site sanitation. BPD Sanitation Series, London, UK.

Seppälä, O.T.(2002) Effective water and sanitation policy reform implementation: needs for systematic approach and stakeholder participation. *Water Policy,* **4(**2002) 367-388. Elsevier Science Ltd.

Stanton, B.F. and Clemens, J.D.(1987). An educational intervention for altering water-sanitation behaviour to reduce childhood diarrhoea in urban Bangladesh. II. A randomized trial to assess the impact of the intervention on hygienic behaviours and rates of diarrhoea. *American Journal of Epidemiology* 125, 292–301.

Strauss, M., Heinss, U. and Montangero, A. (2000). On-Site Sanitation: When the Pits are Full – Planning for Resource Protection in Faecal Sludge Management. In: *Proceedings, Int. Conference, Bad Elster,20–24 Nov. 1998. Schriftenreihe des Vereins fuer Wasser-, Boden und Lufthygiene,2000;* 105:353-60:

Strauss, M., and Montangero, A. (2002). *FS Management – Review of Practices, Problems and Initiatives.* DFID Engineering Knowledge and Research Project-R8056. Consultancy report to GHK, the United Kingdom, 73 p.

Strauss, M. and Montangero, A. (no date). Capacity Building for Effective Decentralised Wastewater Management. FS Management – Review of Practices, Problems and Initiatives. Engineering knowledge and Research project-R8056 DFID/GHK.

Swiss Agency for Development and Cooperation. (SDC) (2004). *Sanitation is a business-approaches for demand-oriented policies*. SDC, Switzerland

Tayler, K. and Scott, R.(2005). Sanitation policy: Why is it important and how to make it work. WEDC Briefing Note: Overview, WEDC, UK

Tchobanoglous, G., Theisen, H. and Vigil, S.A. (1993). *Integrated Solid Waste Management: Engineering, Principles and Management issues*. McGraw-Hill International Editions, USA.

Tiberghien J.E.(2002). *A Holistic Approach to the Assessment of Sanitation Development in Mexican Villages*. Ph.D., Cranfield, UK

Van der Geest, S.(2002). The night-soil collector: bucket latrines in Ghana. *Postcolonial Studies, Vol. 5, No. 2, pp 197–206, 2002*

Vodounhessi, A. and and von Münch, E(2006) Financial Challenges to Making Faecal Sludge Management an Integrated Part of the Ecosan Approach: Case Study of Kumasi, Ghana. *Water Practice & Technology*. **Vol 1,** No. 2

Analysis of the environmental control elements in sustainable residential area planning in China

Dr Zhengnan Zhou

Delft University of Technology, Netherlands

Many newly built residential areas in China are large projects, therefore master planning phase is very important. It is a key issue to consider how to plan an overall spatial form to make the residential area satisfy the sustainable requirements of energy-conserving, resource-recycling, and environment-friendly.

Determination of the overall spatial form of a residential area, which includes aspects such as building arrangement and site planning, is the primary step of residential area planning, and an important factor of formation of characteristics of the residential area. This paper analyzes the environmental control elements that influence the spatial form of residential areas in sustainable residential area planning in China. The control elements discussed involves aspects of the original eco-resources, building arrangement, greening system, and landscape water system in the residential area. A comprehensive analysis of all the elements will provide effective guidance for planning of the overall spatial form of residential areas..

1. Reservation and Utilization of Original Ecological Resources on the Site

Separate assessment of each sustainable factor of the original site, such as vegetation, water body, and typography, can be made through ArchGIS. All the assessments of each factor are overlaid and analyzed, thus a comprehensive analysis of the original ecological resources is achieved, and then an ecological suitability analysis of land use is established. The planning of the residential area should be based on that analysis.

2. Ecologicalized Building Arrangement

Building arrangement in the residential area should be planned in a well-considered and reasonable way. Great importance should be attached to research on land use according to the specific characteristics of the area. Sunshine and wind environment of the area should be well analyzed. The ecologicalized building arrangement can be realized through simulation with application of CFD and ECOTech.

3. Optimization of Green System

The optimization of the green system of the residential area is to achieve the maximum eco-benefit of the system on a certain green space area through reasonable planning of the green system. Key factors, such as plant distribution, spatial form of green system, assessment of the green eco-benefit, should be carefully considered. CityGreen software can be used to assess the green eco-benefit of the original site of the residential area as guidance for planning of the green system, and also to simulate the eco-effect of green system in planning.

4. Sustainable Landscape Water System

A water body system with reasonable distribution based on the gradient and geological features and with good water quality will greatly promote the virtuous circle of local eco-environment. The sustainable landscape water system is mainly represented in the proper arrangement of water body, and recycling of water resources.

The sustainable strategies at the master planning phase are important basis for the construction of sustainable residential area. Furthermore, these strategies are realized completely at the planning and design level, adding no cost to the construction, and therefore can effectively lessen people's worries about the extra cost for making the residential areas sustainable, and can create positive conditions for the sustainable residential areas to become real affordable housing for the mass people.

Keywords: built environment, environmental assessment, residential area planning, sustainable housing

1. Background

With steady economic development and people's increasing demand for improvement in housing condition, many new residential areas are being set up in the cities of China. Today, when "energy saving and pollutant reduction" has become one of the national development strategies, creation of a living environment that is energy-conversing, environment-friendly, comfortable and healthy is becoming an major concern for people. Sustainable residential area has received wide attention, and relevant research and theories have greatly promoted the construction of sustainable residential areas. There are many researches regarding sustainable residential areas and the relevant theories. A shared opinion of the researchers is that a sustainable residential area should be energy-conversing, land-saving and resource-saving, non-toxic and free from pollution, using solar energy, reducing waste, and recycling and reusing materials, energy and resources.

Many newly built residential areas in China are large in size; therefore master planning phase is very important. However, in the present research and construction cases of sustainable residential areas, major technologies can be mainly found in the building of the houses. Only a relatively small amount of studies have been carried out on how to realize sustainable characteristics in the spatial form of the residential areas. Many countries' assessment criteria of sustainable residential area have content regarding "Location and Site planning", but these criteria are mostly regulatory principles, which cannot be directly applied in residential area planning. Usually, the determination of spatial form of a residential area is influenced by factors such as regulations of the city planning administration, opinions of developers, and the design concepts of architects. It is a new challenge of today to create a spatial form which helps to realize the targets of energy-conserving, environmental protection, comfort and healthiness of the residential area through sustainable control methods.

Determination of the overall spatial form of a residential area, which includes aspects such as building arrangement and site planning, is the primary step of residential area planning, and an important factor of formation of characteristics of the residential area. In the process of planning, based on climatic features and environmental characteristics, analysis of the original eco-resources, building arrangement, green system, landscape and open space in the residential area can be carried out. Thus an energy-conserving, resource-recycling, and environment-friendly spatial form can be set up, and then favorable conditions can be created to realize the environmental targets of a sustainable residential area.

Based on our experience of the large number of projects and practices in China, four aspects as the follow will be elaborated.

2. Assessment of Original Ecological Resources on the Site of Residential Area

The original ecological environment of the residential area is the basic environmental foundation which shows the long development process of the site, and is the natural basis for the future development of the residential area. Therefore, the original ecological environment plays a decisive role for the future of the residential area. Paying great attention to the protection and utilization of the original ecological environment, making full use of the positive factors and transforming the negative factors into positive, will greatly benefit the future development of the residential area.

Map overlay method can be used in assessment of the ecological resources on the site of residential area. With software ArchGIS, separate assessment of each sustainable factor of the original site can be made. All the assessments of each factor are overlaid and analyzed, thus a comprehensive analysis of the original ecological resources is achieved, and then an ecological suitability analysis of land use is established. The factors commonly seen in residential area planning include:

2.1 Original Vegetation

Factors such as the coverage area, growth distribution, health condition, and biodiversity of the original vegetation in the site of residential area are the decisive primary conditions for the formation of a virtuous circle in the future in this ecological environment. Under the circumstances that the original vegetation eco-system is complete and healthy, protecting and maintaining the original vegetation and actively guiding and optimizing the system can create favorable conditions for the future development of the environment of residential area. If the original vegetation is weak and incomplete, more protection is needed for the current basic system, and all-around vegetation cultivation should be enhanced to improve vegetation's ecological function of environmental protection.

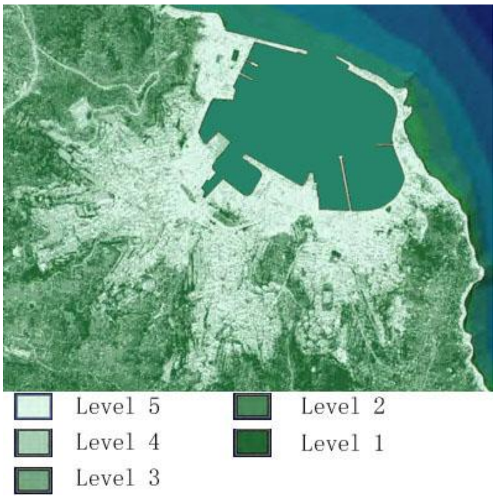


Figure 1: Ecological Assessment of Original Vegetation of a Residential Area in Liaoning Province, China

Figure 1 shows vegetation ecological assessment of the original site of a residential area on an island in Liaoning Province, China. The land-use of this residential area is very large. The situation of the original vegetation was assessed in five levels. Level 1 represents the best situation and level 5 represents the worst. Growth condition and spatial distribution of the vegetation around the land can be clearly seen from the map, which provides the basis for green space system planning.

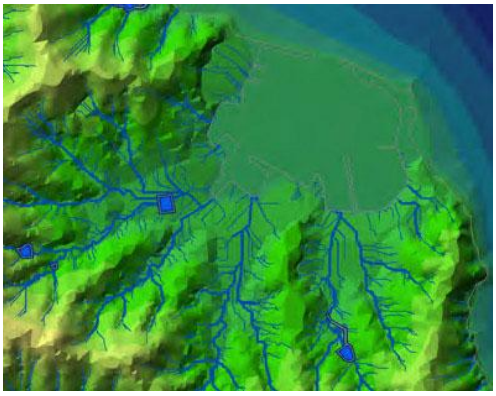


Figure 2: Ecological Assessment of Original Water Body of a Residential Area in Liaoning Province, China

2.2 Original Water Body

The original water body usually reflects the basic geological and hydrologic conditions of an area. Analysis of distribution, source, quality and river basin of the original water can reveal the

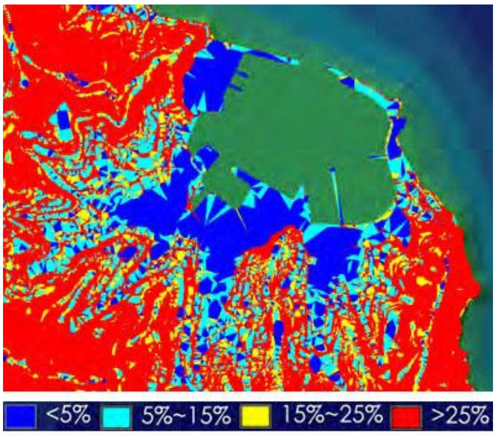


Figure 3: Ecological Assessment of Original Topography of a Residential Area in Liaoning Province, China

basic natural environmental conditions of the area. It is a key issue to reserve the original water body for the maintenance of completeness and sustainable development of the original eco-system.

Figure 2 shows the analysis of the surface water and storm runoff of the original site of the island residential area. The overall planning of the residential area should take influence of the original water body into consideration. Meanwhile, landscape water system planning can be based on the analysis of original water body, and rainwater collection and use can be considered.

2.3 Original Topography

The development of ecological environment is closely related to topography features. Focusing on topography analysis, and finding out the relation between topography and the ecological situation of the region will make it easier to reveal the key adjusting factors in the development of the eco-system of that region, and thus to estimate the effectiveness of other eco-adjusting measures. By protecting the original gradient, unnecessary construction expense can be avoided, and cost for the maintenance of eco-environment can be lessened.

Figure 3 is topography ecological assessment of the original site of an island residential area. Different colors represent different gradients. The red color represents a gradient higher than 25%, and the red places are not recommended to construct buildings. In this residential area planning, the original gradient features should be utilized to the maximum possible extent, and land-use for different purposes should be reasonably arranged according to the gradient.

3. Ecologicalized Building Arrangement in Residential Areas

Building arrangement in the residential area should be planned in a well-considered and reasonable way. Great importance should be attached to research on land use according to the specific characteristics of the area. Sunlight and wind environment of the area should be well analyzed. The planning should be made scientifically, but not by subjective wills of the designers without consideration of the objective situation.

The ecologicalized building arrangement can be realized through

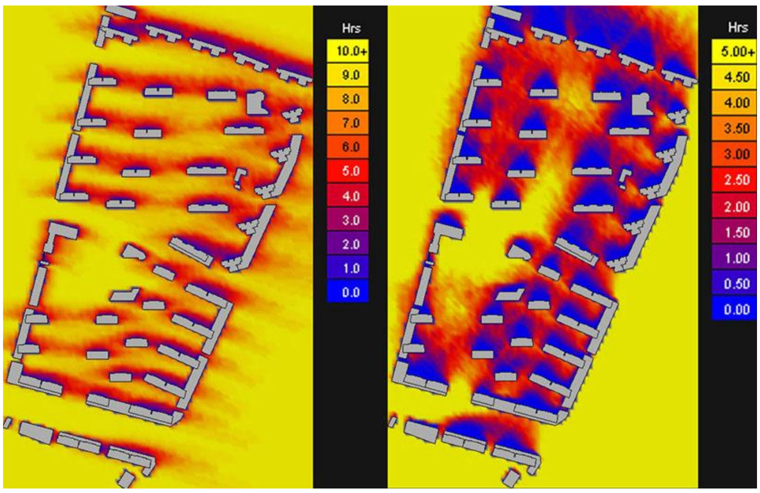


Figure 4: Simulation of the Sunlight Environment in a Planning case of a Residential Area in Hebei Province, China

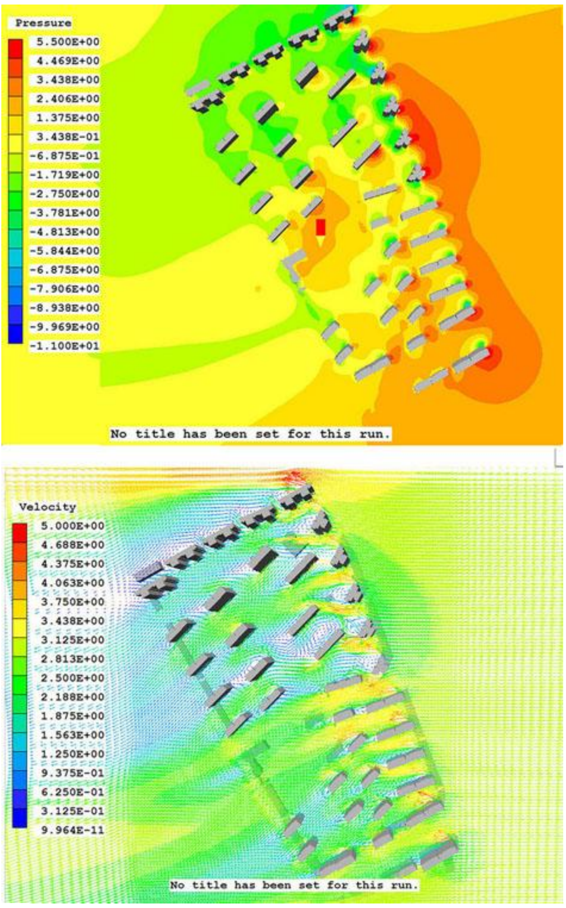


Figure 5: Simulation of the Wind Environment in a Planning case of a Residential Area in Hebei Province

simulation with application of CFD and ECOTech software. The arrangement of building can be ecologically optimized according to the specific climatic and environmental conditions of different regions. Factors involved include:

3.1 Land Use

Land use reflects way of spatial planning of land with different functions in the residential area. Harmonious development of the eco-environment of the residential area should be taken into fully consideration, and land should be used in a way that green system and water body system in the area can be taken good care of. Buildings of different types and functions should be arranged in a reasonable way. Only in this way will the planning benefit sustainable development of human and nature as a whole.

3.2 Sunlight Environment

The sunlight environment of the site should be analyzed accurately and scientifically, to ensure that buildings could operate at a more economical and more reasonable price, and the benefits of the “free energy”, sunlight, can be fully utilized. In this way, energy-conversing can be effectively promoted. Paying great attention to research on building arrangement and sunlight environment of the site from the very beginning of planning will contribute greatly to the general energy saving of the residential area.

Figure 4 is simulation of the summer and winter sunlight environment used in a planning case of a residential area in Hebei Province, China. It's regarded as the best choice after a comparison of a number of solutions, with meeting the requirement of high density as prerequisite. Because a great number of urban residential areas in China at present are with high density and high buildings, it's not easy to ensure that every apartment has plenty of sunlight in the winter months. Besides, according to the sunlight environment simulation, the position and form of public open space can be planned to provide healthy and comfortable outdoor activity space for inhabitants.

3.3 Wind Environment

Wind Environment is also a decisive factor of the energy-conversing effects of the buildings in the residential area. Natural ventilation promotion in transitional seasons, or windbreak and wind speed reduction measures are all active solutions to the wind environment. Meanwhile, optimization of the wind environment of the site will create favorable conditions for indoor natural ventilation of the buildings, and will effectively reduce energy consumption for air conditioning in summer months. Building arrangement and wind environment of the site should be well researched in planning to help promote energy conserving of the residential area as a whole.

Figure 5 is wind pressure simulation and wind vectorgraph simulation of the outdoor wind environment in summer in a planning case for a residential area in Hebei Province, China. Adequate wind pressure is created between the front and back of each residential building through adjustment of building arrangement. Cross ventilation is used to the maximum extent to lower the indoor temperature, so that the working time of air conditioning for cooling in summer can be shortened, and general energy conserving of building is realized.

4. Optimization of Green System of Residential Area

The green system of residential area combines two green space systems: the original vegetation system and man-made green space. The eco-benefit of the green system depends on

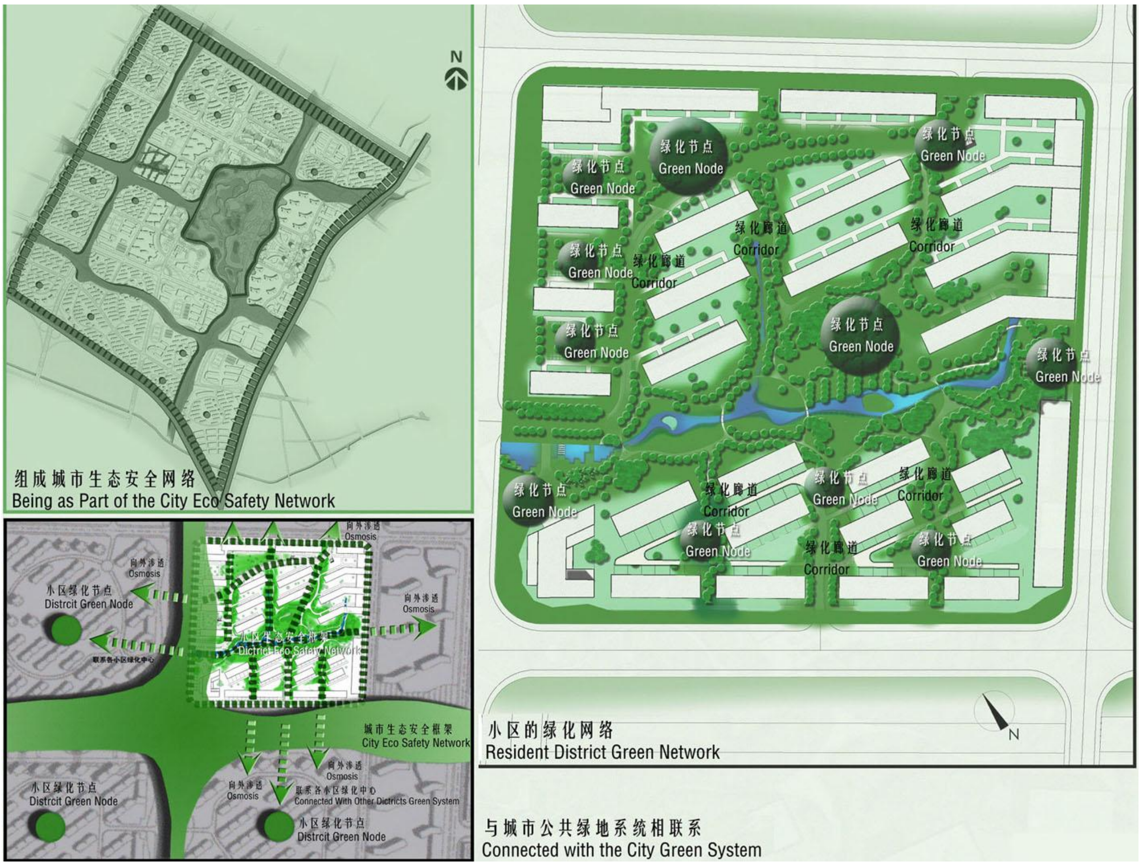


Figure 6: Analysis of the Spatial Form of the Green system in a Planning Case of Residential Area in Jiangsu Province, China

factors such as the external and internal relationships of spatial distribution of vegetation, and the biodiversity and health condition of vegetation. Cultivated green space system is an important structural supplement to the original natural vegetation system, and is the best method to optimize the eco-benefit of the green system, which needs scientific research based on the basic principles and analysis approaches of ecology and reasonable planning.

The optimization of the green system of the residential area is to achieve the maximum eco-benefit of the system on a certain green space area through reasonable planning of the green system. Factors included are:

4.1 Plant Distribution

In the planning of the green system, reasonable plant distribution should be researched based on the actual eco-benefit of vegetation and specific conditions of different regions to develop a favorable environment for plants growing. A control system of green system index based on Leaf Area Index should be established to guide the plant distribution in the green system of the residential area. In this way, a current faulty trend in Chinese garden landscape design, that visual effects are over emphasized as guidance for design, will be avoided and instead, benefits of the green environment to the health of inhabitants will be placed as the first priority.

4.2 Spatial Form of the Green system

Keeping the green system connected in space, and combining usage of three-dimensional greening and vertical greening, will create conditions for biodiversity, and ensure the realization of the eco-benefit of the green system.

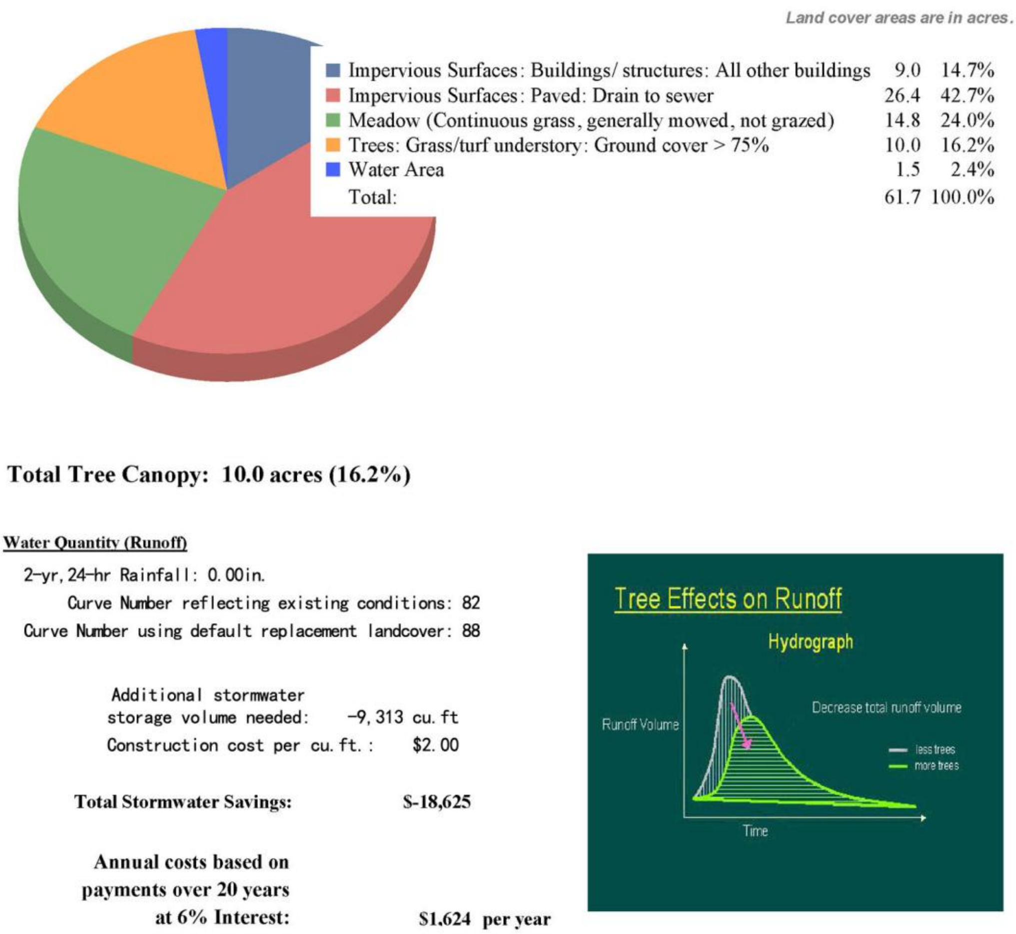


Figure 7: Calculation Date of Eco-benefit of the Green system in a Planning Case of Residential Area in Hebei Province, China

Meanwhile, researches concerning the spatial form of the green system, such as research on the patches and corridor connection structure inside the green system, on the scale and shape of the stepping stones, on the marginal form of the patches, and on scale of the buffer area, are the basis for proper planning of the green system, and for ensuring the full eco-benefit of the green system.

Figure 6 shows analysis of the spatial form of the green system in a planning case of residential area in Jiangsu Province, China. The green space in the area is connected to ensure the greening eco-benefit. Local vegetation network and small vegetation patches are built up to form an ecological security network within the range of the residential area, and to connect with the natural ecological security network of the city.

4.3. Assessment of Eco-benefit

The eco-benefit assessment criteria for green system of residential areas should be improved, and the present assessment in China which takes green space ratio as the only criterion should have a breakthrough. CityGreen, a simulation assessment software, can be used to assess the greening eco-benefit of the original site of the residential area as guidance for planning of the green system, and also to simulate the eco-effect of green system in planning. By establishing an assessment system in which green system spatial form and vegetation plant distribution are combined, basis is provided for planning of green system of the residential area.

Figure 7 shows analysis of eco-benefit of the green system in a planning case of residential area in Hebei Province, China. The eco-benefit of the green system can be estimated through calculation of the software, to provide measurable data for the maximization of eco-benefit.

5.Sustainable Landscape Water System in Residential Area

Water plays an important role in all kinds of circulation in an eco-system. However, water can both bring good or bad results. The quality of water system reflects the quality of local eco-environment. A water body system with reasonable distribution based on the gradient and geological features and with good water quality will greatly promote the virtuous circle of local eco-environment. On the contrary, unreasonable planned water body system with uncontrolled water quality will harm the eco-environment, and even lead to a vicious circle of environmental deterioration.

The sustainable landscape water system is mainly represented in the proper arrangement of water body, and recycling utilization of water resources. Factors included are:

5.1 Original Water Body

Landscape water system is the highlight of the planning of residential area. The planning of the landscape water should fully consider its relationship with the original water body, and combine the landscape water system with the environment of the residential area. Maintenance of the original water body form should be taken as priority of consideration in the planning, and disturbance and change to the ground should be reduced. Dry water course can be restored, and use the original bank-line as possible.

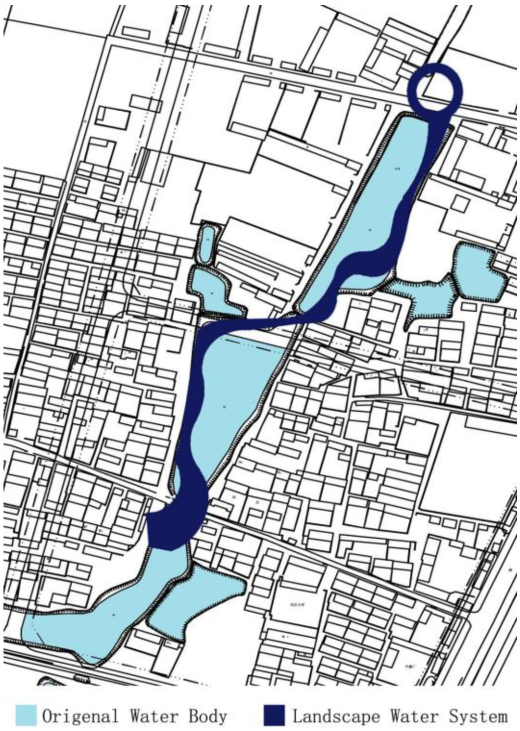


Figure 8: Analysis of the Relationship between the Landscape Water System and Original Water Body in a Planning Case of a Residential Area in Hebei Province, China

Figure 8 shows analysis of the relationship between the landscape water system and original water body in a planning case of a residential area in Hebei Province, China. The original water body has dried for the most part, but the bank-line is basically intact. In the planning of the landscape water system, the original river bank should be used to a maximum extent possible, with a comprehensive consideration of other factors, representing the respect for the original eco-environment.

5.2 Source of Landscape Water

For the selection of the Landscape Water Source, rainwater and domestic sewage should be fully recycled and reused, and should be purified to meet the sustainability requirement of reasonable water resource use. Rainwater and domestic sewage can be treated with biological technologies to serve as landscape water source supply. By application of biological technology in sewage treatment, land can be well used, cost for equipment can be reduced, and daily operational expense will be lowered. For example, soil capillary infiltration technology can be applied to biological treatment, in which sewage water goes through soil filters with aerobic bacteria and anaerobic bacteria separately to be purified to reach the standards of landscape water. Purified domestic sewage can be drained into landscape water system as landscape water,

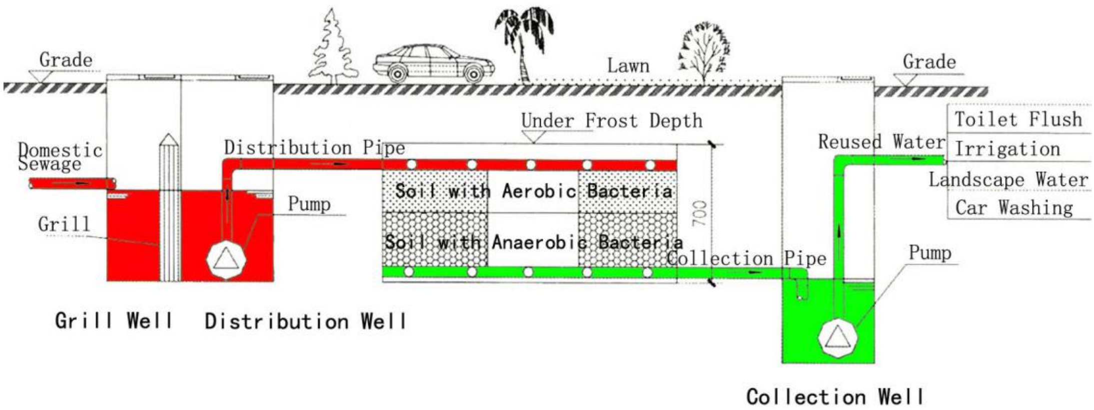


Figure 9: Analysis of Domestic Sewage Treatment with Soil Capillary Infiltration Technology

and as water supply for car washing and irrigation. Figure 9 shows analysis of domestic sewage treatment with soil capillary infiltration technology.

6.Conclusion

By taking the relevant parts of some projects in China as examples, this paper analyzes the environmental control elements that influence the spatial form of residential areas in sustainable residential area planning in China. The control elements discussed involve aspects of the original eco-resources, building arrangement, green system, and landscape water system in the residential area. The computer aided methods provide a great support in the planning process.

A great amount of information can be obtained during the process of control elements analysis. In the formation of the spatial form of residential areas, the function of those different information are interrelated. Therefore, those information should be reorganized and integrated. However, the reorganization should not be a simple gathering, but a integrated and comprehensive consideration based on specific planning of a project.

An integration of analyses of different environmental control elements presented above can provide guidance for planning of the overall spatial form of residential area. The sustainable strategies at the master planning phase are important basis for the construction of sustainable residential area. Furthermore, these strategies are realized completely at the planning and design level, adding no cost to the construction, and therefore can effectively lessen people's worries about the extra cost for making the residential areas sustainable, and can create positive conditions for the sustainable residential areas to become real affordable housing for the mass people.

References:

1. Leon Glicksman (2006). *Sustainable Urban Housing in China: Principles and Case Studies for Low-Energy Design*. Dordrecht: Springer.
2. McHarg, Ian L. (1969). *Design with nature. Garden City*: Natural History Press.
3.Yingxin Zhu & Borong Lin (2004). *Sustainable housing and urban construction in China*. Energy and Buildings, 36 , 1287–1297.
4. Smerdon, T. (1997). *Sustainable Housing: Options for Independent Energy, Water Supply and Sewerage*. Bracknell: BSRIA.
5. Hekkema, Herma & Groenhof Blaauw(1994). *Kattenbroek; a Residential Area in Amersfoort*. Amersfoort: SCW Stichting Centrale Woningzorg.
6. Edwards, B., & Turrent, D. (Eds.). (2000). *Sustainable Housing: Principles and Practice*. Oxon: E and FN Spon.
7. Wheeler, S. (2004). *Planning for Sustainability: Creating Liveable, equitable, and Ecological Communities*. London: Routledge.
8. Xia Wei (2006). *Studies of the Ecological Tactics at the Stage of Design and Planning for Residential District*. Architectural Journal, 04, 25-28.
9. Yu Shijin (2005). *A Method for Evaluating Ecological Features of Planting in Urban Residential Quarter*. Journal of Huaqiao University (Natural Science), Vol. 26, No. 1, 106-109.
10. Gu Zhenhong (2007). *Two Paradigms of Swedish Sustainable Communities: a Case Study of Hammarby Sj Stad and Eco-Villages*. World Architecture, 07, 45-48.
11. Zhuo Gang (2007). *View on the Ecological Problems of Residential Area from the Perspective of Green Residential Area Standards*. Chinese Landscape Architecture, 07, 70-73.
12. Derya Oktay (2002). *Design with the Climate in Housing Environments: an Analysis in Northern Cyprus*. Building and Environment, 37, 1003-1012.

Accounting for sustainability: implementing a residential emissions reduction strategy using an approach that combines qualitative and quantitative 'indicators' of sustainability

Dr Andy Scerri

RMIT University, Australia

Indicators-based projects are currently central to many urban sustainable development initiatives administered by local, city, and national governments, non-governmental organizations and increasingly, commercial interests, such as corporations. However, the quantitative basis of many such projects means that achieving urban sustainability objectives through them is often reduced to a technical task–that of gathering data and 'ticking boxes'. The size, scope, and sheer number of indicators included within many such projects can also mean that indicator sets are often unwieldy. More importantly, unless administered in a 'top-down' fashion, indicators of sustainability can resist effective implementation. This paper begins from the claim that the privileging of quantitative data in some stages of indicator-based projects tends to mask possibilities for taking into account the structures of power and cultural-political assumptions within a city. It is argued that emphasizing quantitative measures, such as indicator sets, without taking into account how they can both reflect and affect existing power and value structures weakens the commitment to methodological holism that is central to the aim of achieving sustainability. In part, the techno-scientific 'edge' of indicators sets tends to privilege 'value-free' information over 'value-laden' knowledges. That is, citizen participation and active involvement do not necessarily figure in selecting indicators of sustainability, and local knowledges and inputs are sometimes overlooked. This is especially important in urban contexts, insofar as the success of sustainability projects so often depends upon locally available resources and conditions, and upon the use of these by citizens to support sustainable practices and to challenge unsustainable practices. This paper elaborates an alternative, two-level process of community engagement for indicators-centred sustainable urban development projects. At the first level, it involves citizens as active participants in the task of developing qualitative rankings of indicators of sustainability across four domains of social practice: economics, ecology, politics and culture. The approach asks participating groups to reflect upon what kinds of things indicate whether or not a city is sustainable, who benefits and who loses by acting to achieve sustainability, and what does it mean, in relation to prevailing values, to negotiate the transition to sustainable practices around indicator sets. At the second level, it uses the understandings developed in the first level as a basis for more deeply involving people in learning about and negotiating over what constitutes knowledge about how best to practice sustainable urban development. Based the experience of recent projects aimed at reducing residential emissions in Melbourne, Australia and Vancouver, Canada, the present paper discusses some of the practical issues that arise when setting out to develop and implement qualitative indicators of sustainability that incorporate quantitative metrics, where the aim of such projects is to engage citizens in the job of achieving sustainability as a set of practices, undertaken on terms acceptable to them in the context of the communities in which they live.

Keywords: assessment focus and flexibility, comparative urban sustainability, indicator development, stakeholder participation, sustainability metrics and indicators

1 Introduction

Over recent decades, indicator-based projects have become central to a range of community-development projects aimed at engendering 'sustainability'. Indeed, it has been argued that "growth in the use of sustainability indicators is nothing short of phenomenal" (Morel-Journel et al. 2003: 617; Rydin et al. 2003: 582). A "sustainability indicators explosion" has been extended across the planet—and on the back of processes of globalization—from neighbourhoods to international policy-making and development initiatives, and from local 'social' entrepreneurialism to multinational corporate 'social responsibility' initiatives. Indeed, one of the most widely-used indicators frameworks, the Global Reporting Initiative (GRI), sees "reducing report proliferation" as a major issue (2006).

Often primarily quantitative in approach, indicators-based projects *are* extremely valuable tools for measuring where an urban area 'is' in relation to some or other given concept of 'sustainability' or 'sustainable development'. However, much urban sustainability work seems to draw a line around indicators and metrics, as if this were enough. Indeed, a key finding of Levett-Therivel's 2004 report to the SUE-MoT consortium was that while "there are plenty of existing sustainability metrics, models and toolkits", it remains the case that "there is no such thing as 'a good tool' in the abstract". The report advises those developing sustainability tools to be aware of the tool's "fitness for purpose". Moreover, the report suggests that, of the "78-plus" tools that were examined, "few … come close to being 'sustainability' tools in terms of being inclusive, holistic, multi-dimensional and capable of simultaneously addressing the social, environmental and economic core issues together with other factors such as political, technical or legal constraints". Indeed, "the concept of a 'true' sustainability tool may be impossible to achieve in practice" (52-53; see also, Castillo et al. No Date: 39-40).

This said, the problem addressed by the present paper is that, in the context of urban sustainable development projects, concentrating upon indicators in themselves does not adequately bring into question the nature of the human relationships that go into creating and reproducing a city on sustainable terms. The main argument is that emphasizing quantitative measures, such as indicator sets, without somehow undertaking the difficult task of accounting for how these can both reflect and affect existing power and value structures weakens the commitment to methodological holism that is central to the aim of achieving sustainability. The suggestion developed here is that indicators-based projects—most often measuring and assessing 'participation' or 'inclusion' in some or other sustainability initiative, as signposts for 'sustainability'—can displace concerns with understanding the city as a *lived* condition as well as a built environment. That is, conceptually, the present paper addresses the interweaving of *science* with *society* in indicators-centred urban sustainability projects.

In short, the paper looks at how the techno-scientific 'edge' of indicators sets can tend to privilege 'value-free information' over 'value-laden knowledges', which raises problems of an applied nature for the job of achieving sustainability. The paper looks at the problem from a perspective grounded in urban planning and community development studies, informed by critical social and political theorizing. The normative argument is, therefore, one that recommends approaching society in terms of *sociality*: the ongoing job of creating and reproducing a social world that is 'the city'. Such a perspective partially reconfigures the task of working to achieve sustainability: the job is re-centred to focus upon a problematic or set of problematics that are inextricably linked to questions of value and power. That is, the task of working to achieve urban sustainability, in reference to some or other set of indicators or metrics is one that needs to be understood in terms of pressing yet difficult to resolve problematics that, nonetheless, need to be addressed (2008: 13).

This is to emphasize that the success or failure of indicators-centred urban sustainability projects is, in important respects, dependent upon negotiated outcomes relating to the selection and application of quantitative metrics. Such a realization is especially important in urban contexts, insofar as the success of projects so often depends upon locally available resources and conditions, and upon the use of these by citizens to support sustainable practices and to challenge unsustainable practices. In these respects, it is suggested that the development and implementation of indicators-centred tools for putting into practice urban sustainability principles is best achieved through the application of a "two-stage tool or process" (Levett-Therivel 2004: 54). Following a brief discussion that aims to thresh-out some of the conceptual and theoretical issues raised above, the latter part of the present paper elaborates a two-level process of citizen engagement for indicators-centred sustainable urban development projects, and draws upon recent experiences in Melbourne, Australia, and to a much more limited extent, Vancouver, Canada. The paper concludes by discussing work on the projects to date, and reflects upon some of the limitations of city-based approaches to the job of achieving sustainability as a holistically conceived goal that the projects bring to light.

2 The case for mixing methods

In the main, the key objective of urban sustainability projects is to develop and implement practices that can ensure that cities are being (re-)created to "meet the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987: 43). More can be said about the meaning of the concept of 'needs' here, but such discussion goes beyond the ambit of the present paper. Nevertheless, within such a definition, indicators of 'sustainability' are in the first instance simply a means for assessing the distance between a current state of affairs and the ongoing task of achieving a sustainable way of life in the context of a given social setting. In the second instance, they can also be much more: a means to the end of instituting debate and agreement over how best to practice the job of *being* sustainable.

To return briefly to the delineation made earlier between 'value-free' information and 'value-laden' knowledges, the point may be merely that indicators-centred projects move too readily from quantitative data sets—taken up from areas as diverse as climatology, the health sciences or econometrics—to making qualitative claims about human experiences, such as well-being, quality of life, the enjoyment of 'natural' light, 'quiet' space or leisure opportunities. This order of argument becomes important when considering suggestions, such as those made by sociologist Gerard Delanty that "Science is increasingly becoming a communicative system that interacts reflexively with society" (2002: 83). Delanty's point may sound like a high-flown way of saying that scientific research, whether 'natural' or 'social', is now almost universally understood as a practice conducted in 'partnerships' with industry, government and civil institutions, philanthropic trusts, and even lottery funds, all of which have needs, desires and ends in mind that can inform and affect research, and the kinds of research that is done. And, moreover, that scientific facts enter the public life-world often and readily: examples are not limited to climate change, and extend to the 'hospital bug scare' and of course, dietary issues that have many pondering 'protein or carbohydrates' before meals. Thus, Delanty's understanding of scientific knowledge, which encapsulates either its 'natural' or 'social' modalities, is valuable.

As the threats posed by climate change to the sustainability of human society become increasingly urgent, 'natural' scientific information about the environment becomes increasingly relevant to ‘social’ scientific concerns with sustainability. Indeed, as philosopher Alisdair MacIntyre recognized several decades ago, the products of 'natural' science are increasingly being produced and acted upon in ways that respond to and represent concerns hitherto seen as part of the ambit of the 'social' sciences and by extension, the humanities (1977). Indeed, all kinds of 'natural' scientific understandings are increasingly becoming politicized: 'the facts' are increasingly subjected to external (that is, 'non-scientific') evaluation and critique. At the same time, science as a whole is being de-mystified, insofar as the presence of what Andrew Dobson, Robin Eckersley and others have labelled "the ecological challenge" (2006) normalizes the place of relatively abstract information *and* the knowledges associated with these within social life. Indeed, at least since the Rio Summit and Brundltand reports, the knowledges created by the 'social' sciences have been increasingly called upon by policy-makers as a means to the ends of preparing societies for climate change, and of developing sustainable ways of living. In this view, 'social' scientific knowledges constitute an aspect of what Peter Wagner sees as "part of the discursive self-understanding of social life". That is to say, the 'social' sciences have come to occupy an "interpretive space" in society. Over the same period, 'natural' scientific information has become a common feature in everyday life, communicated into the 'living room' by the news-media. What is important about such views is that, while representing scientific endeavour as part and parcel of social life, it also helps to break down the "legitimacy deficit" between 'natural' and 'social science' forms of knowledge (2001: 36, 38).

Seeing things in these terms, however, does raise a pressing issue in relation to indicators-centred urban sustainability initiatives: 'natural' and 'social' science methods are fundamentally different. An important point is that, as Bent Flyvbjerg argues, 'natural' science deals with *explanation* and *predictability*. It provides information about the world, which is something that 'social' science is exceedingly bad at (2001: 3). Think about the failure of most political and sociological observers to predict the fall of the Eastern Bloc in 1989 or more recently, the failure of most mainstream economists to predict or explain the current malaise of the markets. The point is that 'social' science deals *reflexively* and sometimes *critically* with *power* and *values* and so, concentrates upon "the interests and institutions that sustain them in the social world". Flyvbjerg argues that 'social' scientific knowledge "is important because it is that activity by which instrumental-rationality is balanced by value-rationality *and* because such balancing is crucial to the sustained happiness of the citizens in any society" (2001: 4, Italics added). In calling for 'social' scientific research to be (self-)understood as the activity of constituting, sustaining and elaborating value-rationality, Flyvbjerg argues for understanding social research as a self-reflexive exercise that may best be defined in terms of developing, debating and propagating *value-consciousness*. Thus, Flyvbjerg argues that the "goal [of 'social' scientific understanding] is one of contributing to society’s capacity for value-rational deliberation and action" (2001: 167).

Therefore, in the argument developed here, 'information' can be said to refer to 'objective' data-type material, whether derived or developed using quantitative or qualitative means. Alternately, 'knowledge' is said to refer to necessarily value-laden claims about information and its uses in a social context. Based in this delineation, the approach discussed here aims at recognizing the value of qualitative approaches while adopting a fundamentally different approach to quantitative indicators-centred projects. It needs to be stressed that the point is not to suggest that 'natural' scientific understandings of the physical universe are unimportant. Indeed, such 'natural' scientific information—about resources or processes within ecosystems, for example—is essential to recognizing the sources and effects of un-sustainability. Rather, the suggestion is that 'natural' sciences need to be defended, indeed championed, in the context of conditions that are also loaded with largely unpredictable social—ecological, economic, cultural and political—possibilities.

The approach advocated here views 'natural' scientific data as one contribution to the creation of knowledges that can support practices aimed at achieving sustainability. On the other side of raw information are the fields of power and values that give shape and form to knowledge, and qualify its uses. Seeing things in this way involves a rethinking of what indicators actually are. In effect, the suggestion is that many of the things that are understood as 'indicators' in quantitative terms need to be taken as sub-indicators or metrics, and embedded within a more comprehensive qualitative framework. In other words, quantitative metrics need to be understood in terms of qualitative judgements. This, it is argued, raises possibilities for developing qualitative rankings of sustainability-in-practice. These can work to de-mystify 'natural' science by facilitating reflections upon and learning about how prevailing forms of authority and criteria for value can and do impact upon a community's capacity to practice sustainable development.

In this approach, quantitative indicators, as well as the 'natural' scientific worldviews that accompany them, become discrete elements of sustainable development in practice. Sustainability indicators are thus treated as merely representing an aspect of *lived* reality. In the approach described here, it is the practical activity by which citizens learn about and select indicators that is seen as having the badly needed potential to change the relationships between people, and between Humanity and Nature, thereby changing people and changing nature (Gare 2008: 6). What is suggested in the present paper is that technical problems need to take the passenger's seat and assume the role of navigator, orienting people in the task of negotiating the form and content of the relations in and through which people create and reproduce a society, or discrete parts of it, such a city or urban community. From here, it might be argued that many of the problems associated with working to achieve sustainability need to be partially re-conceived on *procedural* and *deliberative* terms: that is to say, *living* in a city needs to be better understood as a *learning* condition (Delanty 2003: 558. Other accounts of the centrality to the task of achieving sustainability of learning and negotiating about its 'practices' are developed around concepts of "ecological" or "environmental citizenship". For a comprehensive discussion of such concepts, see Andrew Dobson and Derek Bell (2006)). Quantitative indicators and a qualitative rationale for applying them need to be combined in a procedure that is designed to assist in the practical human task of working to achieve sustainability.

3 Accounting for sustainability

From the perspective of these suggestions, the approach set out here runs complementary to the orientation of the SUE-MoT Integrated Sustainability Assessment Tool, aimed at achieving Whole Life Urban Sustainability in relation to urban development, planning, zoning and infrastructure, for example. As such, it is important briefly to draw attention to one more aspect of the approach, before discussing it in detail through a worked example. One of the outcomes of both an increasing interest in sustainability and an assumed dominance of economic language in policy-making is that many indicators-centred urban development projects work from within a model first developed in economics as an add-on to the bottom line of profit: the ‘triple bottom-line’ (TBL) model. In general, these approaches aim to measure impacts upon the economic, social, and environmental ‘bottom lines’ of a city. In general, (and there are numerous exceptions) the city is treated as a discrete functional unit, much like a business firm, with inputs and outputs, 'internalities' and 'externalities'.

Of course, the three-dimensional approaches are problematic for many, simply because they unquestioningly set the rules, norms and values—the 'ideologies'—associated with the (capitalistic-market) economy in pride of place when evaluating sustainability. This said, and however one feels about such criticism, it does help to clarify an important issue: the TBL approaches often assume a strong commensurability of values between the different domains of human social practice (Martinez-Alier 2002). These TBL approaches, such as the widely used GRI, tend to presume that economic, social and environmental sustainability are either commensurable *a priori* of other considerations, or that the economic domain (which in conditions of globalization grants primacy to efficiency and growth) provides the basis for translating between them. For example, instead of treating the ecological as having its own imperatives, the environment becomes an economic 'externality’; another cost to be considered when engaging in economic activity.

Instead of treating domains of social practice, such as the economy, separately from the social, the approach discussed here starts with ‘the social’ and conceptually divides it into *four domains of practice*: the economic, the ecological, the political and the cultural. This decision is not designed to relegate the social to a background feature of human practice but rather, is a deliberate decision to put *sociality* at the centre of the challenge of achieving sustainability. This means treating the economy as one domain or 'sphere' of social life, rather than as something separated from the social. The economy has its own intrinsic rules, norms and values, which often mean that practices grounded in them encroach upon or affect the sustainability of life-world conditions more generally conceived. The approach also means treating the ecological as a social question, rather than an 'objective' issue manifest in an external Natural environment. (In terms of the theoretical matters that this suggestion raises, grappling with 'the social' in terms of domains or spheres of practice that follow and produce their own rules, norms and values builds upon work by Michael Walzer (1983) and Luc Boltanski, Eve Chiapello and Laurent Thévenot (2006 [1991]; 2005 [1999])).

A working definition of each domain follows:

- The Economic Domain is defined in terms of activities associated with the production, exchange, consumption, organization and distribution of goods and services.
- The Ecological Domain is defined as the intersection between the social and the 'environmental', and focuses upon human engagement with *and* within the non-human world of things (Despite the fact that the natural environment is a material reality that extends beyond the human experience of it, and despite the increasing capacity of techno-science to reconstitute elements of nature, the ecological domain is, at once, *social* and *natural*).

- The Political Domain is defined in terms of what goes into the job of organizing, over time and in a particular space, the rules for a life held-in-common.
- The Cultural Domain is defined in terms of practices, discourses and material objects that express commonalities and differences, continuities and discontinuities of meaning over time.

The approach therefore recognizes a tension between (generative) values across different domains of practice, between human ‘needs’ and ecological ‘limits’ or between socially beneficial 'inclusion' and socially beneficial 'exclusion', for example, which need to be answered in each of the four domains of practice. Meanwhile, it aims to develop an understanding of the need for comparability across (particular) domains: that is, across the different ways in which such an order of social tensions are negotiated. Hence, this not to suggest that the four domains are in practice divided spheres of activity. Rather, the point is that it is analytically useful to treat 'sustainability' in these terms because it is helpful for undertaking the difficult task of negotiating over what needs to change and what needs to stay the same, as well as how to 'indicate' this, if a city is to work towards achieving sustainability.

3.1 The approach in practice: Level One

The approach is therefore aimed at providing a means by which a city and its citizens can *both* account for sustainability in quantitative terms, and account for sustainability in terms of agreeing upon what this requires, in relation to changes to or reinforcement of established rules, norms and values. The present paper now turns to focus upon a specific worked example; a case study of the two-level approach in practice. The approach is currently being piloted in Melbourne, Australia and Vancouver, Canada: it is a work in progress. In order to present things in a clear and concise way, the present paper concentrates upon findings from the Melbourne project, which at the time of writing has advanced further than the project in Vancouver. The point of contact in Melbourne was the Sustainability Team of a progressive city council, which engaged the researchers in order to develop an indicators-set through the Accounting for Sustainability approach for the resident-focussed portion of the city's umbrella Strategy to reduce waste and emissions. The residential portion of the Melbourne Strategy focuses upon minimizing household water and electricity usage and waste (trash) reduction. The point of contact in Vancouver has been a university department and, though academics there, the local regional authority. A considerable amount of preparatory work has been carried out in Vancouver, with the approach being evaluated in relation to existing urban indicators projects. Researchers in Vancouver have focussed upon the dimension within the approach that emphasises fostering value-based thinking on sustainability issues. At the time of writing, decisions in relation to a specific project on which to apply the approach are pending.

Initially, one representative of the Sustainability Team in Melbourne was asked to consider Council's undertaking of the Strategy in terms of four questions:

1. What is the depth of awareness of the issue (reducing household water and electricity usage and waste reduction) in relation to each (economics/ecology/politics/culture) domain?
2. How adequate have been the practical responses to this issue in relation to each (economics/ecology/politics/culture) domain?

3. How appropriate have been the resources brought to bear on this issue in relation to each (economics/ecology/politics/culture) domain?
4. How well have responses to this issue been monitored across each (economics/ecology/politics/culture) domain?

Hence, Level One involves taking steps to begin to rethink the practices and procedures that can make or break sustainable development objectives, and begins with something of a sustainability 'self-assessment' task. This is designed to get the process moving by fostering the production of a record-like 'social map', in relation to which possible indicators to be applied within each of the four domains of practice are selected. The researchers ranked responses to each of the four questions in relation to each domain of practice. Evidence for claims made in relation to each question was provided in the form of policy documents and statements; governmental, institutional and externally generated reports; legislation and by-laws; quantitative data such as statistics and the results of public opinion polls; minutes of meetings and records of community meetings, town planning sessions and council meetings. This took place in conjunction with a series of 'strategic' interviews, designed to establish some of the 'subjective' understandings and expectations of the Strategy held within Council and by the Sustainability Team itself.

A key finding of this early stage of the project has been that there exists something of a misfit between the city's self-understanding of sustainability as a holistic issue (the Strategy understands the 'city as an ecosystem') and the domains of human social practice in which it has moved to achieve 'sustainability'. In short, great emphases were placed upon understandings of 'environmental impact' and economic issues relating to opportunities for increased efficiency, and less on cultural issues. Council was largely unprepared for the emergence of political issues in relation to the strategy, and seemed to understand cultural issues purely in terms of 'community engagement' through its website.

Simultaneously, the researchers undertook to organize and convene a Critical Reference Group (CRG) for the projects. Conscious of the (almost intractable) problem of merely replicating existing social structures, such as hierarchies and vested interests, the group was made up of members of council, including planners, engineers and community outreach workers, civil society organizations and business managers or owners from within the city, including representatives from the electricity and water utilities, and academics. The role of the group was to provide feedback on the unrolling of the project, and to discuss and debate possible shortcomings as these developed, while establishing the basic framework for engaging residents in the city in efforts to achieve sustainability. This strategic part of the project served as a guide and overview of city objectives and hopes for the project, and specifically aimed to identify key participants and those affected by the eventual implementation of the indicators sets.

In summary, this initial stage built-up a profile of the city in relation to the stated objectives of its Strategy, and aimed to situate the city and its strategy as part of 'society' broadly conceived. Level One thus began the process of defining participants and engaging them in negotiating what it is that requires 'indicating', and how or under what conditions such indicators are to be implemented as targets (to be aimed for) or base lines (to be moved on from). In consultation with the CRG it was decided that a series of public meetings and stalls at existing community events, and a questionnaire was to be distributed to householders in the weeks preceding Earth Hour in April 2009. The aim is to better understand householders' expectations about what was to be 'indicated' and how, and to foster community awareness and learning in ways that would eventually lead to the establishment of a quantitative indicators set for the project.

3.2 The Approach in Practice: Level Two

The step from Level One to Two of the approach actively establishes the basis for public participation in the indicators-centred development project. The aim of level Two is to move beyond "feel-good talk of 'participation'" (Cornwall 2008: 270-271), and to ground an "'informatization' process that builds collective community knowledge encompassing hard and measurable trends and facts as well as soft and unmeasurable values and perceptions" (Holden 2006: 179). Participation in Level Two is, therefore, designed to take the form of contesting, negotiating, and self-defining what it is that 'sustainability' will encompass and entail, and what are the particular limitations of this project in relation to this 'global' goal. Thus, Level two involves a double process of negotiation; the aim of going beyond 'traditional' indicators is to prompt negotiating over what constitutes knowledge about how best to practice city life *and* to develop and implement 'indicators' that involve people in learning about and 'doing' sustainability. The key point is that it is only by engaging in the task of deliberating over the norms and values that frame possibilities for implementing indicators that they can guide sustainable development in practice. Hence, the two guiding considerations from Level One are complemented by two further background considerations:

5. Who benefits and who loses in the current situation, and how might this be changed?
6. What does it mean, in relation to current norms, to negotiate these matters?

The key considerations in Level Two were asked of the Sustainability Team and the CRG and will also be central to the community questionnaire preceding Earth Hour. Level Two is designed to elicit reflection upon how some of the most important over-arching issues that inform city life, in the context of wider societal conditions, might contribute to or detract from the goal of achieving sustainable development 'outcomes'. At this point, "invited participation" (Cornwall, 2000) is reversed in the form of an external agency being invited in—from the perspective of householders—to broker the parameters of the project.

Level Two of the project to date has generated much enthusiasm from Council itself, the Sustainability Team and the CRG. Some members of the CRG also began to take on a role of 'householder-citizen advocate', and the group began to understand the project itself as a means for making louder city residents' views on the sustainability of many urban issues. As a way of taking this second level of the project further, the researchers injected into the discussion a number of dialogical 'social themes', with the aim of using these as a framework for negotiating the boundaries within which indicators of sustainability need to be established. These are presented in the form of pairs of related concepts, with each drawing attention to major, fundamental, and historically debated sources of social tension (At the theoretical level, this move by the researchers raises epistemological-normative questions about the 'need for foundations', and the strength or weakness of foundational arguments in relation to providing positive 'answers' to social problems).

4 Conclusion

Rather than summarizing the present paper, this conclusion provides some reflections upon the current status of the Melbourne portion of the project. In moving to Level Two a considerable amount of time has been required to move the project from the social map to identifying major tensions, problems and blockages. The researchers have called upon the Sustainability Team to reflect upon and substantiate the ‘objective’ position of the city in relation to a tension between the need for *participation* (in selecting and implementing practices around indicators of residential emissions) and *authority* (that is, the scientific authority implicit in quantitative indicators and the authority of council to under-gird the implementation process, or even to establish the need for sustainability as a social goal). The assumption here is not that participation is better than authority, or vice versa. Rather, what is being brought into question is the degree to which people participating in social life can do so in a meaningful way, and how they do so in relation to the forms of authority and values exercised within their city, and against those applied within the city but having their source outside or beyond it, in national laws or international treaties, such as the Kyoto Protocol. In short, a tension between participation and authority manifests itself around the application of principles (indicators) for social practice, and this needs to be negotiated dialogically if satisfactory responses to the problem of sustainability are to be reached.

Hence, Level Two builds upon Level One's evaluation of the Strategy. The Accounting for Sustainability approach is in this sense serving to frame negotiations between Council, business, and the community—within the particular constraints of 'the city'—in a 'soft' way, by linking 'natural' to 'social' scientific endeavour and binding both together under the auspices of a recognized *foundational* need to negotiate the terms upon which the task of achieving sustainability is to be implemented. The questionnaire is currently being developed mindful of the need to address the existence of the 'tensions' that arise between desires for citizen participation (and possibilities for it) and authority (in the establishing of indicators by council, as well as council expectations of state and federal authority on the sustainability issue). In this sense, one unexpected consequence of the project so far has been the way it has worked to set in relief—for the researchers, Council and, it is suggested, city residents—both the importance *and* the limitations of "local and subnational climate change" measures (For a recent discussion of the political issues that such 'subnational' initiatives raise, see Schreurs 2008). This is of course seen by the researchers and the CRG as a matter that extends the issue beyond Council's 'patch', thus, signalling all the more explicitly, the need for ways of addressing the task of achieving sustainability in broader, holistic terms that encompass not only local but national and global institutions.

5 References

Boltanski, L. & Chiapello, E. (2005 [1999]) "The New Spirit of Capitalism". London: Verso Books.

Boltanski, L. & Thévenot, L. (2006 [1991]) "On Justification: Economies of Worth". Princeton: Princeton University Press.

Castillo, H., Price, A.D.F., Moobela, C. and Mathur, V. (No Date) Assessing Urban Social Sustainability: Current Capabilities and Opportunities for Future Research, 'The International Journal of Environmental, Cultural, Economic and Social Sustainability', volume 3, issue 3, 39-48.

Cornwall, A. (2000) "Beneficiary, Consumer, Citizen: Perspectives on Participation for Poverty Reduction". Stockholm: Swedish International Development Agency.

Cornwall, A. (2008) Unpacking 'Participation': models, meanings and practices. Community Development Journal, 43, 269-283.

Delanty, G. (2002) Knowledge as Communication: a review of recent literature on method and theory in social science. 'International Journal of Social Research Methodology', volume 5, issue 1, 83-90.

Delanty, G. (2003) Citizenship as a learning process: disciplinary citizenship versus cultural citizenship. 'International Journal of Lifelong Education', volume 22, issue 6, 547-560.

Dobson, A. & Bell, D. (Eds.) (2006) "Environmental Citizenship". Cambridge, MA: MIT Press.

Dobson, A. & Eckersley, R. (Eds.) (2006) "Political Theory and the Ecological Challenge". Cambridge: Cambridge University Press.

Flyvbjerg, B. (2001) "Making Social Science Matter: Why social inquiry fails and how it can succeed again". Cambridge: Cambridge University Press.

Gare, A. (2008) "The Scientific Status of Environmental Accounting Methodologies". (Private author correspondence, 30 March) Melbourne.

Global Reporting Initiative (2006) "Sustainability Reporting Guidelines: Version 3.0". New York: Collaborating Centre of the United Nations Environment Programme.

Holden, M. (2006) "Urban indicators and the integrative ideals of cities". Cities, volume 23, issue 3, 170-183.

Levett-Therivel Sustainability Consultants (2004) "Sustainable Urban Environments - Metrics, Models and Toolkits: Analysis of sustainability/social tools". 9 June 2004, Oxford, UK. Report to the SUE-MoT Consortium.

Macintyre, A. (1977) Epistemological Crises, Dramatic Narrative and the Philosophy of Science, 'Monist', volume 60, 453-472.

Martinez-Alier, J. (2002) "The Environmentalism of the Poor: a study of ecological conflicts and valuation". Cheltenham: Edward Elgar.

Morel-Journel, C., Duchene, F., Coanus, T. & Martinais, E. (2003) Devising Local Sustainable Development Indicators: from technical issues to bureaucratic stakes. The Greater Lyons experience, 'Local Environment', volume 8, issue 6, 615-626.

Rydin, Y., Holman, N. & Wolff, E. (2003) Local Sustainability Indicators, 'Local Environment', volume 8, issue 6, 581-589.

Schreurs, M.A. (2008) From the Bottom Up: Local and Subnational Climate Change Politics, 'Journal of Environment and Development', volume 17, issue 4, 343-55.

Wagner, P. (2001) "Theorizing Modernity". London: Sage Publications.

Wagner, P. (2008) "Modernity as Experience and Interpretation: A New Sociology of Modernity". Cambridge: Polity Press.

Walzer, M. (1983) "Spheres of Justice: A Defence of Pluralism and Equality". Oxford: Blackwell Books.

World Commission on Environment and Development (1987) "World Commission on Environment and Development: Our Common Future". Oxford: Oxford University Press.

Social inclusion and sustainable urban environments: an analysis of the urban and regional planning literature

Chris Landorf

University of Newcastle, Australia

In 2008, the United Nations estimated that for the first time, half the world's population would be living in cities. This is accompanied by predictions that cities will become more violent, unhealthy and socially exclusive. Urban design embodying the principles of sustainable development has been proposed as a means to address these issues but the research linking urban sustainability and socially inclusive communities is limited. This paper seeks to explore how social inclusion is currently being addressed in the assessment of sustainable urban environments. The paper is based on qualitative content analysis of ten recently published urban sustainability studies. The analysis focuses on the contextual use of words associated with social inclusion in each study. Findings indicate that there is agreement on the significance of a socially inclusive environment, but there is limited understanding of how to design and measure it. The paper highlights the difficulties of addressing social inclusivity in the urban design and sustainability assessment process.

Keywords: social inclusion, sustainability assessment, sustainability indicators, urban regeneration, urban sustainability

1 Introduction

In February 2008, the Population Division of the United Nations reported that more than half of the world's population would be living in urban areas by the end of the year. This is anticipated to grow to seventy percent by 2050 with the majority of the growth occurring in the rapidly expanding cities of Africa and Asia (UNDESA 2008: 4). As traditional social structures and basic services struggle to cope with this rapid urbanisation, there are predictions that cities will become more violent, unhealthy and socially exclusive (Basiago 1998: 145). Urban design that embodies the principles of sustainable development has been proposed as a means to address these issues. While the concept of urban sustainability has broadened to include economic and social dimensions as well as environment concerns, there is little research that specifically links urban sustainability theory and its practical application to the development of socially sustainable and inclusive communities. This is despite an increasingly evident association in the developed world between urban sustainability and regeneration programs, and the creation of socially inclusive communities.

This paper seeks to explore how the emerging issue of social inclusion is currently being addressed in the assessment of sustainable urban environments. As background, the paper describes the concept of social inclusion and how public policy has evolved to address the issue. The concept of sustainable development is then considered using the metaphor of a social problem before the paper discusses social sustainability and the use of social sustainability indicators. From the literature, it is clear that the creation of socially inclusive communities is considered an integral factor in the sustainability of urban environments. However, the practical strategies to achieve this are far from clear. Who for example, makes decisions about specific social sustainability issues, what influences those decisions, how are different stakeholders engaged in the process and, more specifically, how are the outcomes measured and assessed. These are all ambiguous issues that challenge mainstream approaches to the design and management of sustainable urban environments.

This paper contributes to the theoretical understanding of socially inclusive urban environments through a qualitative content analysis of ten recently published academic studies assessing urban sustainability. The analysis focuses on exploring the contextual use of key words associated with social sustainability and social inclusion in each study. The findings confirm the issues identified in the literature. While a socially inclusive community is considered an integral part of a broader urban sustainability agenda, there is a limited understanding of how to implement and measure it, let alone integrate it with certainty into the design or planning process. The paper highlights the difficulties of predicting and assessing the impact of urban design and planning on social inclusivity. The paper also illustrates the need to adopt define a framework for social sustainability at the early stages of the process.

2 Social Inclusion

The idea of socially inclusive and hence socially cohesive communities is a key principle of the sustainable development agenda established in the World Commission on Environment and Development's (WCED) *Brundtland Report* (WCED 1987) and the subsequent United Nations Conference on Environment and Development's (or 'Earth Summit') *Agenda 21* (Johnson 1993). Social exclusion refers to the marginalisation and detachment that can be experienced when people are not able to participate fully in society. In terms of the causes, a conventional approach is provided by Clark and Cox (2003) who quote Parkinson as follows:

> *Rapid changes in the economic environment caused by internationalisation and industrial and corporate restructuring have transformed the character of local economies [bringing] a more fragile labour market, a decline in manufacturing and a rise in the service sector, high levels of structural unemployment, an increase in part-time, insecure and low-paid employment, a shift in the balance of male and female employment and a growing gap between the highest and lowest incomes.*

While income and employment are acknowledged as significant contributors to social exclusion, it is increasingly evident that they are not the only factors that need to be considered by policy makers. Issues such as age, disability, neighbourhood, race and religion can contribute to social exclusion independently of income and employment. With this developing understanding, persistent and systemic deprivation in certain areas and amongst certain social groups has resulted in a shift in attention away from an exclusive focus on income related deprivation, to the more inclusive idea of 'capability deprivation' first described in 1983 by economist Amartya Sen. Capability deprivation refers to broader issues such as the capability to participate in community activities, lead a healthy life and live without fear (Saunders 2003: 4).

This approach has resulted in the development of more multi-dimensional definitions. Saunders (2003: 6) for example, quotes a proposal by Burchardt as follows:

> *An individual is socially excluded if he or she does not participate to a reasonable degree over time in certain activities of his or her society, and (a) this is for reasons beyond his or her control, and (b) he or she would like to participate.*

Such definitions still fail to reflect on the underlying causes of social exclusion. As Saunders goes on to point out, they fail to differentiate between situations that are warranted (or legitimate) and unwarranted (or discriminatory), and between involuntary (or imposed) and voluntary (or chosen) exclusion. Despite this lack of definitional consensus, the general concept of social exclusion has now largely subsumed the narrower income related definition of poverty in Europe and other developed countries.

While there is limited consensus about a definition of social exclusion, there is also limited consistency about what is to be measured. There is general agreement that social exclusion should include income and non-income related measures in some form of a multi-dimensional framework. For example, the annual Poverty and Social Exclusion Survey of Britain distinguishes four dimensions of exclusion as exclusion from adequate resources as constrained by income, the labour market, access to services and social interaction (Gordon et al. 2000: 54). In 2001, the European Union agreed on ten primary social indicators that include income, employment, education and health data. The Australian Bureau of Statistics has developed a similar series of multi-dimensional indicators that include indicators of criminal activity, housing adequacy and community participation (Saunders 2003: 14-15). Further to how social exclusion is measured however, is the impact of the concept on social policy.

The shift in social policy away from the stimulation of economic activity to the promotion stronger communities noted above is particularly evident under recent Labour governments in Britain where two strategies have been noted by Bull and Jones (2006: 767). The first is to strengthen local 'networks, norms and social trust', identified as social capital by Putnam. The second is to promote the role of government as a partner who enables social capital through the facilitation of community networks and partnerships. The governance through partnership policy, strongly evident under New Labour and elsewhere in the developed world, has come to imply both democratic renewal and a more efficient delivery of public services.

The concept of 'social capital' has assumed an influential role in political and economic theory, particularly in relation to governance and economic development. The concept is most notably linked to Robert Putnam who defined 'social capital' as 'the features of social organisation, such as networks, norms and social trust that facilitate coordination and cooperation for mutual benefit' (Putnam 1993 quoted by Morgan 1997: 493). Putnam's central thesis, that civic engagement leads to social capital and this in turn provides the basis for effective government and economic development, has been criticised as 'too society-centred and undervaluing state agency and associated political factors' (Lowndes and Wilson 2001: 629). Despite this, the concept lies at the heart of the 'third way' approach to political participation in many European states. The emphasis on strong communities, active citizenship and enhanced political participation, found in New Labour policy in the United Kingdom can be traced to the social capital concept.

Even so, the neo-liberal ideals that stress individual autonomy and a reduced role of the state are still evident and much attention has been given to the political agenda underlying the use of partnerships by New Labour in the United Kingdom as a result (see for example, Davies 2002; Hastings 1996; Lowndes et al. 1997; Lowndes and Skelcher 1998; Lowndes and Wilson 2001). Critics of this approach to social policy have pointed to a variety of flaws. These include the propensity for economic and environmental goals to overshadow social goals (Edwards and Onyx 2007: 18; Littig and Grieβler 2006: 67), the failure of partnerships to guarantee widespread democratic community engagement (Bull and Jones 2003: 771), and the potential for embedded inertia and power structures in some communities to impose constraints on entrepreneurship and widespread social engagement (Harriss and De Renzio 1997: 926). These all have the capacity to accentuate social exclusion rather than inclusion.

3 Social Sustainability

3.1 The accepted model of sustainable development

The most widely accepted model of sustainable development was initially defined in the *Brundtland Report* and then expanded in *Agenda 21*. The model is founded on a state of equilibrium across three interdependent sustainability dimensions – economic, environmental and social. Despite widespread consensus about the general objective of sustainable development, the concept and its operationalisation remain highly contentious. At the forefront of the criticism is that the literature on the subject is characterised by numerous definitions (Boyko et al 2006: 694; Williams 2006: 254). The term is now used in many diverse fields and contexts resulting in a variety of different interpretations, each reflecting specific interests and prejudices. While the Brundltand definition is widely quoted for example, it is also criticised for being too anthropocentric (Evans 1999: 74). Other definitions, such as that proposed by the International Union for Conservation of Nature (IUCN) in 1991 as 'improving the quality of human life while living within the carrying capacity of supporting ecosystems', are criticised for being too ecocentric (Littig and Grieβler 2006: 66). Still other authors advocate a process-oriented definition that emphasises stakeholder participation and progress against agreed performance indicators (Wheeler 2000: 438). Despite these and numerous other attempts, universal acceptance of any one definition remains elusive.

The numerous definitions are also criticised for using vague, ambiguous and contradictory language. For example, the notion of 'needs' in the WCED definition and 'carrying capacity' in the IUCN definition are subject to socially constructed and context specific interpretation (Wheeler 2000: 438; Williams 2006: 254). More specifically, this discursive ambiguity limits common agreement on what sustainable development is and opens the interpretation process up to active manipulation by competing stakeholders in the sustainable development process (Littig and Grieβler 2006: 67). Invariably this politicisation promotes the interests of the more powerful at the expense of the less powerful. The terms 'sustainable' and 'development' are further criticised for being contradictory and mutually exclusive (Edwards and Onyx 2006: 18; Sharpley 2000: 2). This reflects the problem of contextually specific interpretations. For example, a neo-classical economic perspective that promotes economic growth and the efficient resource use is diametrically opposed to an extreme environmental perspective that rejects any exploitation of nature's resources.

A third criticism is that the politicisation of the process impacts on achieving an equitable balance across the economic, environmental and social dimensions of sustainable development. The concept of equitable development is at the heart of the critical debate about the WCED definition. This implies not only balancing the use of resources equitably in an inter-generational context but to also in an intra-generational context (Evans 1999: 76). Inherent in the debate therefore, is the need to balance continued growth in the Third World with a corresponding reduction in growth in the Developed World (Hunter 1997; 854; Mowforth and Munt 1998: 12). This remains one of the most contentious issues in the sustainable development agenda, particularly given the operation of private sector interests outside of national political and jurisdictional boundaries.

A fourth and final criticism is the shear complexity of achieving a balance across the three sustainable development dimensions. The reason for this complexity is identified by Williams (2006: 255) when he suggests that:

> *Sustainable development implies an understanding of highly connected and interdependent social, economic, environmental and political systems; it is grounded in multi-organisational and stakeholder environments; it is framed within a web of administrative, statutory and legal requirements; and it is difficult to disentangle problem structures and their root causes, and the attribute outcomes to specific policy interventions.*

Any progress here clearly relies on a developed sense of global responsibility and corporate citizenship. Achieving a balance is further complicated by the lack of comparable indicators. While there are established economic and environmental performance indicators, there are no such agreed indicators for social sustainability (Littig and Grieβler 2006: 67). Even where social sustainability indicators do exist, they are inherently difficult to argue against the more established and empirically based economic and environmental indicators.

3.2 Sustainable development as a social problem

McCann's definition of a social problem offers a useful framework for further conceptualising sustainable development (McCann 1983). McCann suggests firstly, that social problems are dynamic and unbounded. They do not respect conventional spatial or temporal boundaries between functions, organisations, sectors or jurisdictions. This limits the capacity for developing a shared understanding of their causes and effects, and a coordinated approach to their solution. In the case of sustainable development, there is no universally agreed definition or system for negotiating interventions. The lack of established performance indicators means the three sustainability dimensions are often given different priorities and rarely integrated into an intra-generational and inter-generational whole.

Secondly, McCann suggests that the resources needed to affect a social problem are diffused. This means that any change will need to be undertaken incrementally through negotiation with multiple actors who share complex non-linear relationships. Some of the major issues affecting sustainable development, such as intra-generational equity, require systematic and long-term change founded on an acceptance of global inter-dependency and mutual accountability. Sustainable development also implies a highly complex level of organisational interdependence and integration which makes the outcome of any intervention difficult to predict.

Finally, there is no clearly defined authority with a social problem. New institutional arrangements or legal frameworks are needed to coordinate any intervention. Sustainable development presents a good example of this condition. Issues such as climate change and stakeholder participation require entirely new methods of governance and cross institutional trans-national collaboration. This is further complicated by the socially constructed and politicised nature of sustainable development. Unfortunately, complicated power relationships that reinforce or promote a particular causal theory or interest at the expense of another will adversely affect the balance between the three dimensions of sustainability. As shown in the following section, the metaphor of a social problem is a particularly useful framework for a more detailed analysis of social sustainability.

3.3 Social sustainability

In framing a working definition of social sustainability, the *Brundtland Report* suggests that social sustainability seeks to preserve the environment through economic growth and the alleviation of poverty. While there has been debate about whether environmental sustainability is a prerequisite of economic growth and poverty alleviation, or economic growth and poverty alleviation are needed before environment sustainability can be addressed, the concept of social sustainability identifies a negative link between sustained human occupation, sustained poverty levels, and sustained natural resource exploitation (Basiago 1998: 152). In other words, social sustainability aims to alleviate poverty within the existing resource base of a society. While the practical strategies to bring this about are vague in the *Brundtland Report, Agenda 21* suggests a multi-dimensional approach to social sustainability based on the alleviation of poverty. This is directed through strategies such as security of land tenure, small business development, technical aid and trade liberalisation, as well as the development of social equity and the active participation in social and political community activities (see Johnson 1993).

An extensive critical literature has emerged on sustainable development since the *Brundtland Report* and *Agenda 21.* However, the literature that focuses specifically on social sustainability is limited and ambiguous. This ambiguity is also evident in the previously discussed concepts of 'social inclusion', 'social cohesion' and 'social capital'. Given the overlapping nature of these four social concepts, it is important to identify any common threads before further exploring how the terms are being utilised in practice. Following Putnam's concept of social capital, Bramley and Power (2009: 32) argue that an underlying theme of all three concepts is that socially sustainable communities require individuals to work together in social networks. This recognises the vested interest individuals have in society and the collective responsibility society has to the equitable distribution of social benefits to individuals.

Bramley and Power suggest the three concepts share a further common concern with cultural identity and values, a sense of belonging, and feelings of safety and trust that come with 'the positive side of social control and order.' However, because of a focus on economic opportunity and access to services, social inclusion could be considered a more distinct concept. This argument tends to parallel the criticisms outlined previously about the tendency to favour what is more easily measurable and comparable. It might be argued that the need to integrate measures of economic, environmental and social is precisely why social inclusion is a less precise concept.

With this understanding, three core themes of social sustainability can be detected. The first two are described by Bramley and Power (2009: 32-3) as 'social equity' and the 'sustainability of community'. According to Bramley and Power, social equity relates to 'access to services, facilities and opportunities' while the level of access is mediated by political processes framed within a 'distributive notion of social justice'. For this to occur, a further condition of social equity is suggested, the stability of the institutions that facilitate access. Institutional stability provides an enabling framework for long-term and holistic planning that might not otherwise occur within a decision-making process driven purely by political power and vested interests.

The second theme described by Bramley and Power is community sustainability which refers to the strength of the social networks that facilitate community cooperation, and the level of participation in community activities, both formal and informal. Community sustainability also refers how strongly individuals identify with a community. Bramley and Power argue that the level of an individual's identification will affect their desire to contribute to that community which is reflected in the level of social cohesion. A further condition of community sustainability is suggested, empowerment. For communities to actively engage in the political process there must be a realistic expectation that they can influence the outcomes and be held accountable.

The third core theme of social sustainability relates to the satisfaction of basic human needs. These may be objective issues such as food, shelter and education, as well as subjective issues relating to quality of life such as perceptions of health and well-being. The distinction is made here between social equity, which measures the level of equality in the way resources and opportunities are distributed in a community, and the satisfaction of basic needs, which measures the level of resources and opportunities available to the community as a whole.

For example, a community may be living equitably but for some reason such as drought, war or recession, not satisfying basic human needs.

Finally, consideration needs to be given to the indicators of social sustainability. With no clear concept of what constitutes social sustainability, it is no surprise that there is little agreement on relevant social sustainability indicators. Littig and Grieβler (2006: 68) suggest that, unlike economic or environmental indicators, social sustainability indicators are founded less on developed theory and more on a 'practical understanding of plausibility and current political agendas.' Rydin et al. (2003) emphasise the importance of developing indicators for a local context for reasons associated with community empowerment discussed above. However, there is some need for universally agreed indicators if the three dimensions of sustainability are to be integrated and prioritised. To this end, three core indicators relating to the satisfaction of basic human needs (quality of life), social equity (access to services and opportunity), and the level of social coherence in a community (strength of social networks, participation, identification and tolerance) are suggested (after Littig and Grieβler 2006: 75).

4 Methodology

The study utilised a qualitative content analysis to explore how social inclusion is currently being integrated in the urban sustainability assessment process. Qualitative content analysis uses a systematic classification process of coding and identifying themes to interpret the content of text data. Content analysis focuses expressly on the contextual meaning and characteristics of language as communication in a text (Hsieh and Shannon 2005: 1278). Unlike other methods of textual analysis such as ethnography and grounded theory, content analysis relies on there being some form of existing theory about a phenomenon from which to derive an initial coding framework (Easterby-Smith et al. 2008: 173). Unlike discourse analysis, content analysis does not emphasise the broader social context of a document or the power relations and ideologies represented in language (Easterby-Smith et al. 2008: 182). Discourse analysis is considered more holistic but also a more intuitive method best suited to the critical analysis of implicit concepts embedded in discourse over time.

The study further utilised a summative method of content analysis. The focus of this approach is to discover the underlying meanings and contextual use of words, rather than to count the incidence of words as would occur in conventional content analysis (Hsieh and Shannon 2005: 1283). In this way, summative content analysis allows a more critical approach to be taken to the analysis of discourse and word usage.

The study commenced with a review of previous research conducted on the urban sustainability assessment processes. Studies by the Building Research Establishment (2006) and Levett-Therivel Sustainability Consultants (2004) had extensively analysed a range of sustainability assessment tools. The BRE study included seven specific urban planning tools, three of which were included in the Levett-Therivel study. Both studies concluded none of the tools were sufficiently inclusive, holistic or multi-dimensional to adequately address all three dimensions of sustainable development. A further finding was that the breadth of stakeholder participation, a key element in the implementation of social sustainability, varied greatly (BRE 2006: 26). There was also less consensus about and emphasis on the social sustainability dimension (Levett-Therival 2004: 3).

The study otherwise adopted a five stage approach after Hsieh and Shannon (2005: 1283). *Stage 1* formulated the research question. The initial question was revised following a review of the literature. *Stage 2* provided the sample to be analysed using a quantitative review of electronic journal databases and a qualitative review of journal article content. *Stage 3* defined the categories to be applied in the coding process. This stage provided two operational definitions that represented acceptable constructs of the key concepts being addressed based on the literature. *Stage 4* outlined the coding process. The literature revealed a broad consensus in terms of the component elements of the two operational definitions. These elements were extracted from the literature and used as the basis of the content analysis of the journal articles identified in *Stage 2*. *Stage 5* analysed the data starting with an initial familiarisation process followed by a quantitative computer based search for keywords. This provided a general profile of keyword frequency illustrating the focus of each article and the extent that social sustainability was seen as a multi-dimensional social issue. This was followed by a qualitative analysis of the contextual use each keyword which provided a richer understanding of whether implicit or ambiguous meanings were being attributed to key concepts in each article.

5 Results

5.1 Stage 1: the research question

The study initially intended to review how sustainability assessment tools addressed the issue of social inclusion. The BRE and Levett-Therival studies however, already provided a comprehensive and review of current sustainability assessment tools. It was decided therefore, to extend this approach to explore how social inclusion was currently being addressed in academic studies of sustainable urban environments. The research question therefore, was refined following the literature review to How is social inclusion being addressed in current academic literature assessing the sustainability of urban environments?

5.2 Stage 2: the sample frame

The draft Australian Research Council (ARC) Research Output Rankings were used to select appropriate journals for review. The Rankings provide a list of over 20,000 journals grouped into research fields ranked according to publication rates, citation averages and impact factors. A search was undertaken in the Urban and Regional Planning sub-group of the Built Environment and Design research field which includes community planning, urban and regional analysis, and development and urban design. Ninety-seven journals were ranked in the sub-group, fourteen ranked as A*, the best in the field, and twenty-five ranked as A, very high quality publications (ARC 2008: 21).

Home pages for A* and A classified journals were reviewed. Ten journals that included terms relating to sustainable urban development in their aims and objectives were selected for an electronic database keyword search. Journals were searched for articles published between January 2005 and December 2008 that contained the term 'urban sustainability' or 'sustainable urban'. Abstracts of 104 identified articles were reviewed and ten were selected for further study. The final articles were selected on the basis of a reference to the term 'social', 'socially' or 'socio' in the title, abstract or body of the article, and a focus in the research on the practical application of sustainability theory to social issues in the urban environment.

5.3 Stage 3: the categories for analysis

Categories are themes or patterns expressed directly in the text or derived from the text through analysis. In this study, operational definitions of two categories were developed from the literature to guide the analysis as follows and shown in their component elements in Figure 1:

- *Social sustainability* is the terminology used when urban development adopts a long-term (future oriented) and holistic (integrated across dimensions and stakeholders) approach to the provision of environments that satisfy basic human needs, foster social equity and encourage community sustainability.
- *Social inclusion* is the terminology used when urban development fosters an environment that is conducive to individual identification with and participation in social networks and encourages socially cohesive and politically empowered communities.

	basic human needs	
Social sustainability	social equity	
	community sustainability	
		identification
	the individual	
		participation
Social inclusion		
		cohesion
	the community	
		empowerment

Figure 1: Component elements of the operational definitions

5.4 Stage 4: the coding process

The coding process aims to organise large quantities of text into fewer categories based on common themes or content. The coding process starts with an initial familiarisation with each text. A coding scheme is then used to guide the organisation of the data into thematic categories. In this study, a ten keyword coding scheme was derived from the literature and operational definitions. The ten keywords are shown in Table 1. After an initial familiarisation, the coding process involved the identification of keywords in the sample journal articles using a computer assisted search. This was followed by a manual review of the contextual use of identified keywords aimed at revealing any conflicting or ambiguous meaning in the use of keywords, or the operation of an implicit dominant discourse in the communication (Fairclough 2003).

Table 1: Keywords identified from the operational definitions

Operational Definition	Keywords
Social sustainability	1. social sustainability
	2. social inclusion
	3. social exclusion
Social inclusion	4. social capital
	5. social cohesion
	6. social networks
	7. equity
	8. participation
	9. empowerment
	10. identity

5.5 Stage 5: the data analysis

The data analysis commenced with an initial familiarisation process. The ten journal articles identified in Stage 2 were read by the author. The aim or purpose of each article, the methodology or approach, key findings and any implications of the research were noted and categorised. The author/s background as an academic or professional were also noted. Each article was then subjected to a computer assisted search for the occurrence of the ten keywords identified in Table 1. Word frequency counts for each keyword were calculated. Finally, the contextual use of each keyword was assessed. This was done to firstly, determine the emphasis placed on social as against economic or environmental sustainability issues, and secondly, to examine how each concept was applied and inherently understood by the author/s.

A summary of the aim, methodology, findings and implications of each article is provided below and further summarised in Table 2. The journal name, title of the article and the author/s identity are concealed. This is followed by an examination of the results for the quantitative and qualitative keyword analysis. Results for the word frequency counts are shown in Table 3.

5.5.1 Journal article summary

Article A is written by an academic with a background in urban planning and sociology. The article aims to analyse the implications of urban renewal policy on social equity and diversity in the UK. The research uses textual analysis to review recent academic research and policy documents. The author uses logical argument to conclude that key policy concepts need greater empirical research and clearer definition, particularly in relation to social interaction and stakeholder participation. The article provides limited detail as to how this might be achieved in practice.

Article B is written by an academic from the field of urban sustainability. The article seeks to identify the key features of a high quality urban environment. The research uses textual analysis to examine conceptualisations of quality in the built environment in the academic and UK public policy literature. The author uses logical argument to posit a generic framework of ten inter-related and inter-dependent features of a quality urban environment. The interpretation of community as a place based issue is only briefly considered and the framework is not applied.

Article C is written by an urban planning academic. The article aims to analyse the capacity of urban planning policy to deliver sustainable urban environments in fast growing region of Australia. The research uses textual analysis to review current policy documents. The author uses logical argument to conclude that more direct intervention is required by government in public transport and employment creation to achieve sustainable centres. The article provides limited detail as to how this might be achieved in practice.

Article D is written by two academics from the field of geography. The aim of this article is to report on community evolution in an informal Brazilian neighbourhood, and review the causes of social exclusion. The research uses documentary evidence observational studies, physical and self-report surveys to determine quality of life measures. The findings suggest that community participation in the assessment process has an empowering effect. The authors assume therefore, that the assessment process has the potential to produce locally appropriate sustainability initiatives.

Article E is by an academic with a background in geography and urban policy. This article describes a project that aims to generate indicators of urban quality and sustainable development for a city in Canada. The project uses an action research approach with a focus on expert and community based participation in the indicator development process. The authors conclude that multiple stakeholder involvement and consensus building can generate common indicators. The authors do not comment on the practical application of those indicators to sustainable development.

Article F is written by two academics from urban planning backgrounds. The article aims to examine how the physical and social characteristics of an historic neighbourhood in Mexico contribute to a sustainable urban environment. The research uses documentary evidence observational studies, physical and self-report surveys to evaluate sustainability using six environmental and three social measures. The authors conclude that community networks are an effective means of delivering government sustainability interventions. The choice of indicators is not clearly argued nor is the relationship between the indicators and community sustainability.

Article G is by two academics from urban planning with a transportation planning specialisation. This article aims to test the claim that compact cities contribute positively to urban sustainability. The research applies structural equation modelling to eighteen variables from ninety-two cities in Taiwan. The authors conclude that the compact cities have a positive impact on economic sustainability but a negative impact on environmental and social sustainability. The research relies on available statistical data. Social sustainability is therefore limited to quantifiable issues only.

Article H is by two academics from an urban planning field, one with a background in architecture and the other specialising in transportation. The article aims to measure components of an urban environment that promote social sustainability. The research uses documentary analysis, physical surveys and computer aided design software to evaluate sixteen indicators in two Australian neighbourhoods. Indicators described in the literature as important to promoting sustainability are used but the link is not proven and social sustainability is interpreted as a place based issue only.

Article I is written by an academic from a landscape architecture background. The article aims to test the practical application of the principles of sustainable urban development on a Bangkok neighbourhood. Scenario modelling is used to test two future scenarios, one where current development practices continue and one where sustainable practices are implemented. The author uses a two dimensional planning approach with a focus on community as a place based issue but the research indicates how generic principles can be theoretically applied to a locally specific context.

Article J is written by a practitioner from the field of urban planning. The article examines stakeholder participation in an urban renewal project in Turkey. The research used documentary analysis and self-report surveys to determine participation in the decision-making processes. The findings suggest the process is dominated by powerful public authorities and private organisations. The author assumes therefore, that a poor participation process will negatively affect urban sustainability.

Table 2: Summary of journal article aims, methods and findings

Article	**Aim (research location)**	**Method**	**Findings**
A	To determine the implications of urban renewal policy on social equity and diversity (Europe).	textual analysis	additional empirical research required
B	To identify the key features of a quality built environment (Europe).	textual analysis	framework of generic features proposed
C	To analyse the capacity of urban policy to deliver sustainable urban environments (Australasia).	textual analysis	greater public intervention required
D	To review the causes of social exclusion in an informal settlement (South America).	case study	stakeholder involvement can be empowering
E	To describe a project generating indicators for a sustainable urban environment (North America).	action research	stakeholder involvement can be empowering
F	To link physical and social characteristics to sustainable development (Central America).	case study	social networks can effectively deliver policy
G	To test the claim that compact cities contribute positively to urban sustainability (East Asia).	mathematical modelling	compact cities negatively impact sustainability
H	To measure components of an urban environment that promote social sustainability (Australasia).	CAD modelling	framework of generic features proposed
I	To model the practical application of sustainable urban development principles (South-East Asia).	scenario modelling	framework for localised scenario models proposed
J	To examine stakeholder participation in an urban renewal project (Middle East).	case study	inequitable participation can be negative

Three articles were categorised as theory building because of their focus on the critical analysis of current government policy or academic literature. Article A considers both current research and government policy on urban renewal while Article C examines current research and government policy in relation to the characteristics of a high quality built environment. Article C focuses specifically on the impact of government policy on urban sustainability.

Three articles were categorised as theory testing. These articles focus on the theoretical application of urban sustainability concepts. Article G uses a deductive mathematical modelling approach based empirical sustainability indicators. Article I uses an inductive scenario building approach based on the assumed impact of certain interventions over time. Article H relies on quantitative measurement of urban characteristics, the only applied study in this category. All three articles emphasise the measurement and analysis of causal relationships and variables rather than the analysis of process evident in Articles A, B and C.

Four articles were categorised as practical interpretation. The focus of these articles is on descriptive field work and multiple sources of evidence. While all the articles seek to identify causal relationships amongst variables within certain situational constraints, Article E explores a project specifically designed to democratise the sustainability policy and development process. Article D, Article F and Article I centre on the implementation of sustainability interventions in situations where broad democratic decision-making is limited.

5.5.2 Keyword summary

Table 3 shows the data from the keyword frequency count. Five articles record a high percentage of citations for one specific keyword. Article D uses the term 'social exclusion' nineteen times, Article F and Article G use the term 'social sustainability' six and twenty-eight times respectively, and Article E and Article J use 'participation' fifteen and twenty-five times respectively.

Table 3: Journal article keyword frequencies

Keywords	**Keyword frequencies for each journal article**									
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
1. Social sustainability	0	3	0	0	0	6	28	1	0	0
2. Social inclusion	1	2	0	0	0	0	0	0	0	0
3. Social exclusion	5	1	0	19	0	0	0	0	0	1
4. Social capital	0	0	0	2	0	0	0	0	0	0
5. Social cohesion	5	1	0	2	0	0	0	0	0	0
6. Social networks	1	0	0	1	0	0	0	0	0	0
7. Equity	1	2	0	0	2	2	1	1	0	2
8. Participation	3	0	0	5	15	1	0	1	2	25
9. Empowerment	1	0	0	3	2	0	1	0	0	0
10. Identity	1	2	0	0	0	0	0	1	0	0
Total	**18**	**11**	**0**	**28**	**19**	**9**	**30**	**4**	**2**	**28**

Note: Keywords discussed in endnotes were included but not keywords in references.

The keyword recording the highest citation frequency was 'participation' with fifty-two citations. While participation was cited twenty-five times in one article, it was also cited in seven of the ten articles. The second most cited keyword was 'social sustainability' which was recorded thirty-eight times across the ten articles. Twenty-eight of those citations however, were recorded in one article. The third most cited keyword was 'social exclusion' with twenty-eight citations. Again, one article accounted for nineteen of those citations. 'Social capital' and 'social networks' recorded the least number of citations with two each. Table 4 shows the total number of keyword citations across all ten journal articles

Two keywords recorded the broadest citation frequency across the ten articles. 'Equity' and 'participation' were both used in seven of the ten articles. Three keywords were recorded in four of the ten articles, 'social sustainability', 'social exclusion' and 'empowerment'. All of the ten keywords were recorded at least once. 'Social capital' was cited in only one article and 'social networks' in two articles. Table 4 shows the number of journal articles citing each keyword.

Table 4: Total number of keyword citations and articles citing each keyword

Keywords	**Total keyword citations across all articles**	**Number of articles citing each keyword**
1. Social sustainability	38	4
2. Social inclusion	3	2
3. Social exclusion	26	4
4. Social capital	2	1
5. Social cohesion	8	3
6. Social networks	2	2
7. Equity	11	7
8. Participation	52	7
9. Empowerment	7	4
10. Identity	4	3

The high percentage of citations for one specific keyword is more evident in the articles categorised as theory testing and practical interpretation. Two of the theory building articles had a broader spread of keyword use. Article A used eight of the keywords and Article C used six of the keywords while the only keywords used in Article C were in the title and three references to 'social' in the context of the three sustainability dimensions. Article D also used six of the keywords.

Given the rationale outlined for social sustainability as addressing basic human needs, social equity and community sustainability (identification, participation, cohesion and empowerment), what is significant in Table 3 and Table 4 is the low number of different keywords cited in seven of the ten articles. This was reinforced by closer examination of the contextual use of keywords in each article. Only one article defined social sustainability as having a social equity and a community sustainability dimension. One article made reference to social justice and intra-generational equity before proceeding to focus on the physical qualities of neighbourhood as a measure of social sustainability. A third made reference to social sustainability twenty-eight times, stating that social sustainability is 'generally concerned with security, livability and social equity.' A fourth article concluded that their study of the physical qualities of an urban environment ' can be related to the social sustainability of places.'

Considering the limited attention given each article to defining the component elements of social sustainability, it is not surprising that social inclusion (or exclusion) also received little attention. The article that provided a definition of social sustainability was also the only article that also provided a definition of 'inclusiveness' as 'the ability of all people to achieve their potential without suffering the negative effects of, for example, unemployment, low income, poor housing and bad health. Of the four articles that referred to social exclusion, only one defined it using the International Labour Organisation definition as a 'process of social disintegration, a progressive rupture of the relationships between the individual and society'. The same article argued that social exclusion has a disempowering impact on marginalised social groups and is strongly linked to economic disadvantage.

6 Conclusion

The purpose of this study has been to explore how social inclusion is currently being addressed in the assessment of sustainable urban environments. This was done through a content analysis of ten recently published academic journal papers addressing the issue of urban sustainability. With reference to the metaphor of a social problem, the preceding discussion invites a number of conclusions for the future of sustainability assessment. Firstly, sustainable development and social sustainability are highly contested concepts. There would even appear to be unwillingness amongst academics to define social sustainability as it relates to urban sustainability. This is despite there being increased reference to urban environments as contributors to social sustainability and inclusion in government policy. The lack of adequate definition limits the development of a shared understanding and gives rise to a variety of strategies to operationalise and measure it. Framing can have a significant influence on the identification of a problem, implementation of strategies to address it and development of indicators to measure it. It is important therefore, that urban sustainability academics and practitioners work toward an appropriate conceptual definition.

Secondly, because of the breadth of issues and the complicated inter-relationships between them, a long-term and holistic approach to socially sustainable and inclusive urban environments needs to be taken. The challenge for academics and practitioners alike is firstly, how to develop effective strategies that can be coordinated in a consensual fashion over different regions, cultures and timescales. A second challenge is how to measure the impact of any intervention given the complexity of interdependent and difficult to measure variables. Important to this agenda is not only the development of consistent indicators that can be adapted to local contexts, but also to develop reliable indicators for the tangible and intangible dimensions of social sustainability and social inclusion. This requires a stronger agenda of applied research utilising academic-practitioner partnerships.

Finally, the effectiveness of any emerging urban sustainability assessment framework will be challenged by the socially constructed and politicised nature of sustainable development. Several of the journal articles reviewed in this study provided constructive evidence of the complicated power relationships that reinforce or promote particular interests at the expense of others. What remains is to develop a more consistent means to measure the adverse affects of any imbalance in decision-making structures. Despite the good intentions and rhetoric evident in the ten journal articles analysed in this study, it is evident that there is a way to go before many of the issues highlighted in this paper as contributors to a socially sustainable and inclusion urban environment, are integrated into the urban design and sustainability assessment process.

7 References

Australian Research Council (ARC) (2008) 'ERA Indicator Descriptors'. Canberra: Commonwealth of Australia.

Basiago, A D (1998) Economic, social and environmental sustainability in development theory and urban planning practice, 'The Environmentalist', volume 19, issue 2, 145-161.

Boyko, C T, Cooper, R, Davey, C and Wootton, A B (2006) Addressing sustainability early in the urban design process, 'Management of Environmental Quality: An International Journal', volume 17, issue 6, 689-706.

Bramley, G and Power, S (2009) Urban form and social sustainability: the role of density and hourins type, 'Environment and Planning B: Planning and Design', volume 36, issue 1, 30-48.

Building Research Establishment (BRE) (2006) 'Assessment of Sustainability Tools'. Report No 15961. Unpublished report for SUE-MoT.

Bull, A and Jones, B (2006) Governance and social capital in urban regeneration: A comparison between Bristol and Naples, 'Urban Studies', volume 43, issue 4, 767-786.

Clark, M and Cox, S (2003) Combating social exclusion: focus groups, local employment and development: A Preston case study. In: S Buckingham and K Theobald (eds.) 'Local Environmental Sustainability'. Cambridge: Woodhead Publishing Limited.

Davies, J S (2002) The governance of urban regeneration: A critique of the 'governing without government' thesis, 'Public Administration', volume 80, issue 2, 301-322.

Easterby-Smith, M, Thorpe, R and Jackson, P R (2008) 'Management Research', 3rd ed. London: Sage.

Edwards, M and Onyx, J (2007) Social capital and sustainability in a community under threat, 'Local Environment', volume 12, issue 1, 17-30.

Evans, M (1999) 'Principles of Environmental and Heritage Law'. St Leonards, NSW: Prospect.

Fairclough, N (2003) 'Analysing Discourse: Textual Analysis for Social Research'. London: Routledge

Gordon, D, Adelman, L, Ashworth, K, Bradshaw, J, Levitas, R, Middleton, S, Pantazis, C, Patsios, D, Payne, S, Townsend, P and Williams, J (2000) 'Poverty and Social Exclusion in Britain'. York: Joseph Rowntree Foundation.

Harriss, J and De Renzio, P (1997) Missing link' or analytically missing? The concept of social capital, 'Journal of International Development', volume 9, issue 7, 919-937.

Hastings, A (1996) Unravelling the process of 'partnership' in urban regeneration policy, 'Urban Studies', volume 33, issue 2, 253-268.

Hsieh, H F and Shannon, S E (2005) Three approaches to qualitative content analysis, 'Qualitative Health Research', volume 15, issue 9, 1277-1288.

Hunter, C (1997) Sustainable tourism as an adaptive paradigm, 'Annals of Tourism Research', volume 24, issue 4, 850-867.

International Union for Conservation of Nature (IUCN), United Nations Environment Program (UNEP), Worldwide Fund for Nature (WWF) (1991) 'Caring for the Earth'. http://www.iucn.org/about/work/initiatives/futureofsustainability/definitions/index.cfm accessed 16/01/09.

Johnson, S P (ed.) (1993) 'The Earth Summit: The United Nations Conference on Environment and Development'. London: Graham and Trotman.

Levett-Therivel Sustainability Consultants (2004) 'Sustainable Urban Environment – Metrics, Models and Toolkits: Analysis of sustainability /social tools'. Unpublished report for SUE-MoT.

Littig, B and Grießler, E (2006) Social sustainability: A catchword between political pragmatism and social theory, 'International Journal of Sustainable Development', volume 8, issue 1/2, 65-79.

Lowndes, V, Nanton, P, McCabe, A and Skelcher, C (1997) Networks, partnerships and urban regeneration, 'Local Economy', volume 11, issue 4, 333-342.

Lowndes, V and Skelcher, C (1998) The dynamics of multi-organisational partnerships: An analysis of changing modes of governance, 'Public Administration', volume 76, issue 2, 313-333.

Lowndes, V and Wilson, D (2001) Social capital and local governance: Exploring the institutional design variable, 'Political Studies', volume 49, issue 4, 629-647.

McCann, J E (1983) Design guidelines for social problem-solving, 'The Journal of Applied Behavioral Science', volume 19, issue 2, 177-192.

Mowforth, M and Munt, I (1998) 'Tourism and Sustainability: New Tourism in the Third World'. London: Routledge.

Morgan, K (1997) The learning region: Institutions, innovation and regional renewal, 'Regional Studies', volume 31, issue 5, 491-503.

Rydin, Y Holman, N and Wolff, E (2003) Local sustainability indicators, 'Local Environment', volume 8, issue 6, 581-589.

Saunders, P (2003) 'Can Social Exclusion Provide a New Framework for Measuring Poverty?' Sydney: Social Policy Research Centre.

Sharpley, R (2000) Tourism and sustainable development: Exploring the theoretical divide, 'Journal of Sustainable Tourism', volume 8, issue 1, 1-19.

United Nations Department of Economic and Social Affairs Population Division (UNDESA) (2008) 'World Urbanization Prospects: The 2007 Revision, Highlights'. New York: United Nations.

Wheeler, S (2000) Planning Sustainable and Living Cities. In: R T Le Gates and F Stout (eds.) 'The City Reader'. London: Routledge, 435-445.

Williams, P (2006) The governance of sustainable development in Wales, 'Local Environment', volume 11, issue 3, 253-267.

World Commission on Environment and Development (WCED) (1987) 'Our Common Future'. Oxford: Oxford University Press.

Social sustainability: a review and critique of traditional versus emerging themes and assessment methods

Dr Andrea Colantonio

Oxford Brookes University, UK

In recent years the social dimension (or 'social sustainability') has gained increased recognition as a fundamental component of sustainable development. Previous research on sustainability has been mostly limited to environmental and economic concerns. However, social sustainability has begun to attract interest in the Academia, receiving also political and institutional endorsement as part of the sustainable communities agenda and the urban sustainability discourse. Thus, the paper explores the notion of social sustainability and its main assessment methods, together with the pioneering social sustainability framework devised by the City of Vancouver, Canada. The paper illustrates how there is no consensus on the definition of social sustainability because this concept is currently being approached from diverging study perspectives and discipline-specific criteria, which make a generalised definition difficult to achieve. In addition, traditional 'hard' social sustainability themes such as employment and poverty alleviation are increasingly been complemented or replaced by 'soft' and less measurable concepts such as happiness, social mixing and sense of place in the social sustainability debate. This is adding complexity to the analysis of social sustainability, especially from an assessment point of view. Within this context, the paper builds upon the recent 'reductionist' versus 'integrated' sustainability assessment debate and contends that there is paucity of social sustainability assessment methodologies as such. Indeed, at practical level, social sustainability assessment is often conducted (i) through social impact assessment (SIA), which is extended to incorporate biophysical and economical variables or (ii) by broadening the definition of 'environment' and hence the thematic coverage of theme-specific assessment such as SIA. In terms of indicators, the analysis suggests that the development of new sustainability indicators is increasingly focused on measuring emerging themes rather than on improving the assessment of more traditional concepts such as equity and fairness. Indeed, the latter continue to be measured mainly in terms of income distribution and other monetary variables, hampering a meaningful progress in the assessment of social sustainability. Within this context, the paper also pinpoints the main differences between 'traditional' and 'sustainability' indicators, suggesting a set of characteristics for the latter. Despite these hindrances, the paper looks at how Vancouver's local authorities have approached urban social sustainability and discusses the importance of the selection of sustainability principles, objectives, themes, assessment techniques and indicators from a social perspective. Lastly, the paper concludes suggesting possible future directions within the social sustainability debate and the challenges that will have to be overcome to assess the progress toward sustainability. These include for example the examination of more elusive and 'soft' social concepts as larger sectors of communities and societies become more affluent and less worried about the satisfaction of basic needs, but also the increase of uncertainty concerning how different typologies of impact and assessment techniques should be integrated together.

Keywords: assessment, assessment methods, emergence, impact assessment, place, policy, reductionism, social capital, social inclusion, sustainability assessment, sustainability indicators, sustainability metrics and indicators, sustainable community index, sustainable development, urban regeneration, urban sustainability

1. Introduction

In recent years the social dimension (or 'social sustainability') has gained increased recognition as a fundamental component of sustainable development, becoming increasingly entwined with the delivery of sustainable communities discourse and the urban sustainability discourse. Environmental and economic issues dominated the sustainable development debate at its beginning whilst it is only in the late 1990s that social issues were taken into account within the sustainability agenda. Although its growing recognition has spurred an emerging body of literature on social sustainability, our understanding of this concept is still fuzzy and limited by theoretical and methodological constraints stemming from its context and disciplinary-dependent definitions and measurements. As Sachs (1999) puts it, at a fundamental level, it is still unclear whether the concept of social sustainability means the social preconditions for sustainable development or the need to sustain specific structures and customs in communities and societies.

Thus, the aim of this paper is twofold. Firstly, it endeavours to deconstruct the concept of social sustainability and to explore its evolutionary meaning, highlighting the shift from the analysis of traditional 'hard' social policy areas towards emerging 'softer' research and policy-making themes. It is important to clarify that this paper does not seek to provide operational definitions of, or normative prescriptions for, social sustainability. Rather, it debates alternative readings of social sustainability in the light of past, present and possible future interpretations of this concept. The second main objective is to examine the theoretical and methodological approaches to (social) sustainability assessment within the context of the ongoing debate regarding the level of integration of assessment techniques, themes and metrics.

The paper is divided in four main parts. It begins with an overview of the main interpretations of social sustainability that illustrates how different worldviews amongst social scientists have thus far prevented an unequivocal and widespread acceptance of the themes at the heart of this notion. The second part illustrates how impact assessment is evolving into sustainability assessment (SA), and new appraisal methods and metrics are emerging in the sustainability literature. In this context, the analysis highlights the main differences between 'traditional' and 'sustainability' indicators, suggesting a set of characteristics for the latter. The third part provides an overview of the social sustainability framework devised by Vancouver's municipal authorities, which shows how social sustainability can be addressed at the practical level. The paper concludes with an examination of possible future directions within the social sustainability debate and the challenges that will have to be overcome to assess the progress toward sustainability.

2. Social Sustainability

There is general agreement that the different dimensions of sustainable development (e.g. social, economic, environmental and institutional) have not been equally prioritised by policy makers within the sustainability discourse [Drakakis Smith, 1995]. This is mainly because sustainable development was born out of the synergy between the emerging environmental movement of the 1960s and the 'basic need' advocates of the 1970s, but also because assessing the intangible nature of social aspects of development presents measurement quandaries, which will be discussed later. As a result, there is limited literature that focuses on social sustainability to the extent that a comprehensive study of this concept is still missing. Indeed, Littig and Grießler (2005) argue that approaches to the social sustainability concept have not been grounded on theory but rather on a practical understanding of plausibility and current political agendas. In addition, a recent study by the OECD (2001) points out that social sustainability is currently dealt with in connection with the social implications of environmental politics rather than as an equally constitutive component of sustainable development.

These fragmented approaches to social sustainability are also criticised by Metzner (2000) who contends that social sciences and social policy research have developed a plethora of social objective strategies and measurement instruments, but with little regard for the sustainability perspective. Thus, while there exists abundant social research studies and policy documents, these have rarely been integrated into the sustainability framework. Even when cross-discipline approaches have been attempted, covering for example the environmental and the social dimensions of sustainable development within the 'ecological footprint' concept (Reed and Wackernagel, 1996), it can be argued that such endeavours have only been partially framed within an integrated approach to sustainability.

As a result, the concept of social sustainability has been under-theorised or often oversimplified in existing theoretical constructs and there have been very few attempts to define social sustainability as an independent dimension of sustainable development. For these reasons, it can be argued that the relationships between the different dimensions of sustainable development or indeed between 'sustainabilities' are still very much unclear. For example, Assefa and Frostell, 2007 contend that social sustainability is the finality of development whilst economic and environmental sustainabilities are both the goals of sustainable development and instruments to its achievement. Similarly, Hardoy et al (1992) dispute interpretations according to which social sustainability is defined purely as the social conditions necessary to support environmental sustainability. Furthermore, no consensus seems to exist on what criteria and perspectives should be adopted in defining social sustainability. Each author or policy maker derives their own definition according to discipline-specific criteria or study perspective, making a generalised definition difficult to achieve. Nonetheless, several definitions are reported in Table 1, which provides an overview of the plethora of social sustainability interpretations.

In Table 1, it can be seen how in Sachs' views (1999) socio-economic development is an open ended historical process, which partially depends on human imagination, projects and decisions subject to the constraints of the natural environment and the burden of the living past. Thus, social sustainability can be interpreted as a socio-historical process rather than a state. In this perspective, the understanding of social sustainability cannot be reduced to a static zero-one situation where zero suggests an unsustainable situation and one indicates presence of sustainability.

From a strictly sociological standpoint Littig and Grießler (2005: 72) emphasise the importance of both 'work', which is a traditional anchor concept in the German sustainability discourse, and 'needs' as defined by the Bruntland Commission (1987). Similarly, Biart (2002: 6) highlights the importance of social requirements for the sustainable development of societies. Despite the confusion over the meaning of social capital, his approach emphasises the importance of 'time – frames' and 'social conditions' for the long term functioning of societal systems. However, in his analysis there is no reference to the physical environment, allowing for the traditional criticism that sociology has often suffered from a neglect of the physical and non-social realm (Omann and Spangenberg, 2002).

A more comprehensive definition of social sustainability with a special focus on urban environments is provided by Polese and Stren (2000: 15-16). They emphasise the economic (development) and social (civil society, cultural diversity and social integration) dimensions of sustainability, highlighting the tensions and trade-offs

Table 1: Examples of definitions of Social Sustainability

A strong definition of social sustainability must rest on the basic values of equity and democracy, the latter meant as the effective appropriation of all human rights – political, civil, economic, social and cultural – by all people	Sachs (1999: 27)
…a quality of societies. It signifies the nature-society relationships, mediated by work, as well as relationships within the society. Social sustainability is given, if work within a society and the related institutional arrangements satisfy an extended set of human needs [and] are shaped in a way that nature and its reproductive capabilities are preserved over a long period of time and the normative claims of social justice, human dignity and participation are fulfilled.	Littig and Grießler (2005: 72)
[Sustainability] aims to determine the minimal social requirements for long-term development (sometimes called critical social capital) and to identify the challenges to the very functioning of society in the long run	Biart (2002:6)
Development (and/or growth) that is compatible with harmonious evolution of civil society, fostering an environment conducive to the compatible cohabitation of culturally and socially diverse groups while at the same time encouraging social integration, with improvements in the quality of life for all segments of the population	Polese and Stren (2000: 15-16)

between development and social disintegration intrinsic to the concept of sustainable development. However, they also acknowledge the importance of the physical environment (e.g. housing, urban design and public spaces) within the urban sustainability debate. Within the context of urban areas, other authors also maintain that social sustainability interpretations emphasising social equity and justice may assist cities in evolving to become 'good' places by facilitating a fairer distribution of resources and a long term vision (Ancell and Thomposon-Fawcett, 2008).

Similarly, from a housing and built environment perspective, Chiu (2003) identifies three main approaches to the interpretation of social sustainability. The first interpretation equates social sustainability to environmental sustainability. As a result, the social sustainability of an activity depends upon specific social relations, customs, structure and value, representing the social limits and constraints of development. The second interpretation, which she labels 'environment-oriented', refers to the social preconditions required to achieve environmental sustainability. According to this interpretation, social structure, values and norms can be changed in order to carry out human activities within the physical limits of the planet. Lastly, the third 'people-oriented', interpretation refers to improving the well-being of people and the equitable distribution of resources whilst reducing social exclusions and destructive conflict. In her study of the social sustainability of housing, Chiu (2003) adopts the second and third approach to demonstrate how social preconditions, social relations, housing quality and equitable distribution of housing resources and assets are key components of sustainable housing development.

Other authors do not provide a general definition of social sustainability but suggest the main key themes at the basis of the operationalisation of this notion. A number of these key themes are listed in Table 2, which shows how basic needs and equity are consistently being held as fundamental pillars of social sustainability. These concepts are deemed necessary for the physiological and social survival of human beings and communities as a whole. This is because, at a basic level there can be little doubt that shelter, food, clean water and employment are essential requirements for the sustainability of individuals and communities. Similarly, equity is considered a crucial component of social sustainability because of the increasing evidence that societies with lower levels of disparity have longer life expectancies, less homicides and crime, stronger patterns of civic engagement and more robust economic vitality (GVRD, 2004).

The chronological analysis of social sustainability themes also shows how traditional themes, such as equity, poverty reduction and livelihood, are increasingly been complemented or replaced by more intangible and less measurable concepts such as identity, sense of place and the benefits of 'social networks'. Table 3 illustrates this shift from 'hard' themes towards 'softer' concepts within the sustainability discourse, which in recent years has spurred a wider debate on the role that governments and policy-makers should play in delivering 'soft' objectives. For example, with regard to happiness, Ormerod and Johns (2007) question the ability of governments to embark upon happiness-oriented policies whilst they are still struggling to deliver on existing commitments. By contrast, Layard (2007) notes that governments have been interested in happiness at least since the Enlightenment, but only recently they have begun to measure the concept and explain it systematically. Thus, understanding the conditions conducive to human happiness in all their complexity should be the central concern of social science.

Table 2: Key themes for the operationalisation of social sustainability

Feature	Author
• Livelihood • Equity • Capability to withstand external pressures • Safety nets	Chambers and Conway (1992)
• Inclusion • Equity • Poverty • Livelihood	DFID (1999)
• Equity • Democracy • Human rights • Social homogeneity • Equitable income distribution • Employment • Equitable access to resources and social services	Sach (1999)
• paid and voluntary work • basic needs • social security • equal opportunities to participate in a democratic society • enabling of social innovation	Hans-Böckler-Stiftung (2001)
• social justice • solidarity • participation • security	Thin et al (2002) DIFD
• education • skills • experience • consumption • income • employment • participation	Omann and Spangenberg (2002)
• basic needs • personal disability • needs of future generations • social capital • equity • cultural and community diversity • empowerment and participation	Baines and Morgan (2004) and (Sinner et al, 2004)
• interactions in the community/social networks • community participation • pride and sense of place • community stability • security (crime)	Bramley et al (2006)

Table 3: Traditional and Emerging Social Sustainability Key Themes

Traditional	Emerging
Basic needs, including housing and environmental health	Demographic change (aging, migration and mobility)
Education and skills	Social mixing and cohesion
Employment	Identity, sense of place and culture
Equity	Empowerment, participation and access
Human rights and gender	Health and Safety
Poverty	Social capital
Social justice	Well being, Happiness and Quality of Life

Despite these disagreements, for the purpose of this paper, it can be argued that social sustainability concerns how individuals, communities and societies live with each other and set out to achieve the objectives of development models, which they have chosen for themselves taking also into account the physical boundaries of their places and planet earth as a whole. At a more operational level, social sustainability stems from actions in key thematic areas encompassing the social realm of individuals and societies, ranging from capacity building and skills development to environmental and spatial inequalities (see Colantonio, 2007 for a complete list). In this sense, social sustainability blends traditional social policy areas and principles such as equity and health, with issues concerning participation, needs, social capital, the economy, the environment, and more recently, with the notions of happiness, well being and quality of life. The different role played by principles, objectives, targets and themes in the purse of social sustainability will be reviewed in the remainder of this paper.

3. Sustainability Assessment

3.1 Key features

Over the last few decades, a plethora of approaches and methods for the assessment of sustainability have been devised by an increasing body of literature. For example Dalal-Clayton and Sadler (2005) and LUDA (2006) identified at least 27 sustainability assessment (or sustainability appraisal) techniques that have recently emerged in the literature and are distinguished by different theoretical underpinnings and practical applications. This increasing number of assessment methods mirrors the rise in importance of sustainable development on the political agenda of several western governments and the calls for the appraisal of policies, programmes, plans and projects against sustainability criteria.

Broadly speaking, sustainability appraisal is a form of assessment that aims to inform and improve strategic decision making (Sheate et al, 2008). The assessment relies on the application of a variety of methods of enquiry and argument to produce policy-relevant information that is then utilised to evaluate the consequences of human actions against the normative goal of sustainable development (Stagl, 2007 : 9). Indeed, as Gasparatos et al (2008) suggest, sustainability assessments ought to:

- integrate economic, environmental, social and increasingly institutional issues as well as to consider their interdependencies;
- consider the consequences of present actions well into the future;
- acknowledge the existence of uncertainties concerning the result of our present actions and act with a precautionary bias;
- engage the public;
- include equity considerations (intragenerational and intergenerational).

Sustainability assessment builds on Environmental Impact Assessment (EIA), Social Impact Assessment (SIA), and Strategic Environmental Assessment (SEA). Figure 1 provides a succinct overview of EIA, SIA, SEA and SA, clarifying some of the differences and similarities between these main assessment methods families. The diagram offers snapshots of selected definitions, main characteristics and limitations of these forms of assessment. These are meant to summarise rather than replace the very extensive and comprehensive coverage of assessment related issues that can be found in the abundant literature in this field. Despite being a less mature assessment framework than its predecessors there is general agreement that sustainability assessment is characterised by four main features. These include (i) the importance of objectives and principles-setting, (ii) an emphasis on integration of techniques and themes, (iii) the call for multi-criteria approaches, and (iv) stakeholders'

Figure 1: Overview of main methods to assess sustainable development and its dimensions

Increasing integration, strategicness and comprehensiveness of themes and methods

	Since 1960s EIA	1970s SIA	1990s SEA	2000s
Selected definitions and objectives	A public process by which the likely effects of a project on the environment are identified, assessed and then taken into account by the consenting authority in the decision-making process	A systematic, iterative, ex-ante form of assessment that seeks help individuals, groups, organizations and communities understand possible social and cultural, or economic impacts of change, or better still impacts of proposed change	A form of environmental assessment intended to identify and assess the likely significant effects of a plan, programme or a policy on the environment, the result of which are then taken into account in the decision-making process	A form of strategic assessment that integrates environmental, social and economic parameters and relies on the application of a variety of methods of enquiry and argument to produce policy-relevant information in order to evaluate human actions against the normative goals of sustainable development
Main Features	• Focus on environmental dimension of sustainable development, though it may include separate social considerations • Physical/Quantitative approach to the measurement of selected variables • Selection of objective but contextual targets and thresholds • Limited to project level	• Focus on social dimension • Speculative in nature, does not provide precise, accurate and repeatable results • The selection of targets and thresholds relies on system values and political objectives rather than scientific criteria • Primary, secondary, cumulative and 'dead-weight' effects are difficult to calculate and measure	• operates at a strategic level • stresses process rather than detailed technical analysis • foundations in EIA but by nature more open-ended, consultative and iterative than EIA • No need for sophisticated and expensive data gathering and modelling capacity • inter-institutional cooperation and public participation key determinants of success	• Integration of sustainable development dimensions • relies upon principles and objectives rather than targets and thresholds • acknowledge the existence of uncertainties concerning the result of our present actions and act with a precautionary bias • engage the public • include equity considerations (intra-generational and intergenerational).
Examples of main limitations	• Ignores politics and models of decision making • Too narrow focus on bio-physical environment	• Quality and availability of data at the local level • 'Social engineering' risk	• Environmental effects hard to predict at strategic level • Achieving integration	•Quantification issues •Trade-offs, aggregation and weights difficulties

EIA= Environmental Impact Assessment; SIA=Social Impact Assessment; SEA: Strategic Environmental Assessment; SA= Sustainability Assessment

Source: Author, Glasson et al (2005), Glasson (2001), Barrow (2000), EU (2003), Imperial College Consultants (2005), Saunders and Therivel (2006), Stagl, (2007), Sheate et al, (2008), Gasparatos et al (2008), LUC and RTPI (2008), Schmidt et al (2008) participation in the assessment itself The in-depth analysis on these aspects is outside the scope of this paper. Here, it is worth briefly reviewing the first two only.

(i) Importance of objectives and principles-setting

Sustainability appraisal is a form of strategic assessment linked to guiding principles and the achievement of policy objectives. Within this context, Pope et al (2004) distinguish an objective-led appraisal and a principle-based assessment approach to sustainability. The former is similar in nature to SEA, in which the assessment is carried out to achieve specific policy goals within an explicit framework encompassing environmental, social and economic objectives. The latter is led by objectives derived from broader sustainability principles. In their views, the objective-led appraisal focuses on the appraisal of the 'direction to target', which is usually indicated with '+' '0' or '-' for a positive, neutral and negative move toward the sustainability target. Conversely, the principle-based assessment goes beyond the mere establishment of a 'direction to target' and endeavours to establish the 'distance from target', that is, the extent of progress toward sustainability.

(ii) Integration of techniques and themes

The emphasis in sustainability appraisal is on integration because many approaches to sustainability assessment can be said to be example of 'integrated assessment' derived from EIA and SEA, which have been extended to incorporate social and economic considerations as well as environmental ones (Pope et al, 2004; Dalal-Clayton and Sadler, 2005). For example, Pope (2007) argues that sustainability assessment can be seen as the 'third generation' of impact assessment processes, following project EIA and the SEA of policies, plans and programmes. From this perspective, EIA-based integrated assessment has been adopted as a sustainability appraisal method by simply replicating the one-dimensional form of assessment in the three-pillar model of sustainable development. This allows for the discrete assessment of the potential environmental, social and economic changes of a proposal and reflects a systemic 'triple bottom line' approach to sustainability (Elkington, 1994).

3.2 Conceptual Scope and Range of Social Sustainability Assessment

From a social sustainability perspective, there is paucity of specific sustainability assessment methodologies as such. The assessment is often conducted through social impact assessment (SIA), which is extended to include other sustainability pillars. For example Hacking and Guthrie (2007) maintain that the extended coverage of sustainability appraisal is being accommodated by 'stretching' EIA or SEA and broadening the definition of 'environment' and hence the thematic coverage of theme-specific assessment such as SIA. However, they question the real level of integration of these techniques because in their views SIA may be undertaken on its own, as a component of EIA, in parallel with EIA, or as part of an 'integrated' S&EIA. It is also worth pointing out that these diverse impact assessment techniques were not designed for sustainability appraisal per se. As a result, their semantic or substantive integration may not be able to capture, address and suggest solutions for a diverse set of issues that affect stakeholders with different values and span over different spatial and temporal scales (Gasparatos et al, 2007).

Within this context, in a recent study of 20 Environmental Statements (ESs) concerning randomly selected urban regeneration projects implemented in the UK between 1998 and 2007, Glasson and Wood (2008) point out that SIA is covered in 80 percent of the cases, often in a separate chapter. According to their analysis, the scope of SIA content has widened from the 1990s experience to cover population profile and occupational groups; economic and business context; learning and employment; general well being, health, crime and deprivation; community facilities and services; recreation and public open space; and social inclusion and community integration. Further, they argue that there is increasing evidence of best practices in project-SIA after 2004, partly because of the publication of the Planning and Compulsory Purchase Act (UK Government, 2004) and the Sustainability Appraisal of Regional Spatial Strategies and Local Development Document (ODPM, 2005).

However, they also note that there is limited evidence of a sustainability approach that set the SIA and ESs within a wider sustainability context. This is for example because (i) only 50% of ESs contain methodological information that goes beyond a bland descriptive review of population and employment baseline (ii) there is insufficient analysis of the links between socio-economic components (e.g. between demographic profile and jobs created), (iii) quantification is limited and mainly focused on demographics, employment, services and facilities provision, and (iv) the assessment methods showed limited community engagement and reduced involvement of a wide range of stakeholders.

Lastly, at a more conceptual level it can also be argued that another fundamental problem for the deployment of SIA within a sustainability perspective concerns the target and threshold-setting exercise inherent to the impact assessment itself, which presents problems when applied to social settings. Indeed, the bad experience of the 1960s makes social scientists hesitant to formulate normative targets and thresholds, and there can be little doubt that social engineering policies of the 1960s have been criticised for promoting ill-conceived social formulations (Omann and Spangenberg, 2002). In addition, social objectives against which to assess social sustainability need to be contextualised within different development models and system values. These range from neoliberalism policies to the European social security model and to more eclectic approaches to development adopted by transitional economies and continuing socialist countries.

4. Social Sustainability Metrics

Historically, long lists of indicators were established to describe the complexity of sustainable development, with special focus on its environmental dimension. A recent study by Therivel (2004) showed that two thirds of sustainability indicators addressed environmental concerns. More recently, these rather technical lists have been enlarged to include social indicators. Long lists have also been simplified and reduced to sets of core indicators (Hens and De Wit, 2003), which are 'bundled' into sustainability themes, objectives and guiding principles. These elements are interlinked together and constitute the backbone of most sustainable development policies.

In terms of social sustainability metrics, previous work from Colantonio (2007) pointed out how

- the evolution of indicators shows how older indexes prioritise the basic needs component whilst indicators developed more recently seem to emphasise the importance of governance, representation and other institutional factors (see Colantonio, 2007 for a review of this evolution).
- in older indexes the elements taken into account were technically weighted together with other dimensions of sustainable development in an attempt to deliver an integrated approach to sustainability. However, in later sustainability indicators the final decision about trade-offs is de facto left to 'sound judgement', as well as leadership and communication skills (Egan, 2004).
- the 'community' and the 'local level' have re-emerged as main spatial and operational space for the pursuit of sustainability.
- there has been a shift from purely statistics-based indicators toward hybrid sets of indicators that mix quantitative data and qualitative information.

Broadly speaking, the review of recent developments and trends in social sustainability assessment and measurement also suggests a broad distinction between 'traditional social indicators' and 'social sustainability indicators', which is summarised in Table 4. According to this categorisation, it can be argued that traditional social indicators are used for the analysis of discrete issues accessible to specific methodologies related to individual themes

Table 4: Characteristics of Traditional Social Indicators and Social Sustainability Indicators

Traditional Social Indicators	**[Emerging] Social Sustainability Indicators**
Static	Intergenerational and incorporating uncertainty
Predominantly quantitative	Hybrid
Product	Process
Descriptive	Strategic
Mono-dimensional	Multi-dimensional
Target oriented	Principles and objective driven
Top down selection	Deliberative and reiterative selection

that are linked to targets rather than objectives. They are also often selected by panels of experts in national and regional statistical offices. They focus on targets or outcomes and provide a static analysis of national and regional social phenomena.

By contrast, social sustainability indicators are concerned with the integration of multidimensional and intergenerational issues inherent to the notion of sustainability. Their selection is informed by sustainability principles and objectives, which stem from a deliberative and reiterative participation process involving a wide array of stakeholders and local agents. Moreover, sustainability indicators are process indicators in the sense that they analyse the processes through which sustainability principles and objectives are defined, themes agreed and solutions implemented. They allow the monitoring of the actual implementation of a project or a phenomenon and assess the progress towards specific objectives in a more interactive way than traditional social indicators.

To briefly clarify and exemplify these differences we can look, for example, at how poverty would be 'measured' from a 'traditional perspective' as opposed to a 'social sustainability perspective'. The traditional approach to measuring poverty involves establishing an income threshold and calculating how many individuals, families or households fall below it (Townsend and Kennedy, 2004). Poverty is measured in a discrete way and linked for instance to a poverty reduction target. By contrast, from a sustainability perspective, poverty would be measured together with its main manifestations – e.g. ill-health, inadequate housing, limited access to basic services etc- in a multi-dimensional index that integrates the processes and factors conducive of poverty. These include for example marginalisation, inability to access to education etc.

From an operational perspective, however, the aggregation of singles indexes and dimensions presents several difficulties. For example, current integrative frameworks still do not allow a meaningful aggregation of diverse metrics. Keirstead, (2007), for instance, comments that it is not clear how data of fuel poverty and quality of life can be combined into a single social sustainability metric. Even if data can be normalised and weighted, it proves difficult to aggregate social, environmental, economic and institutional metrics into a composite index that can be compared at both spatial and temporal levels.

At present, a well established and widely used methodology to aggregate incommensurable data into a composite index is to use a 'common currency' such as money and land or to use matrices and rose diagrams that pull out data as colours (Therivel, 2004). After a common currency is established, this is predominantly used for cost – benefit assessment or analysis. A good example of this methodology is monetary valuation or deliberative or contingent monetary valuation, in which market monetary values or willingness to pay for specific goods or services by stakeholders are used as comparable currency to assess the costs and benefits of proposals. These technique, however, have been considered ethically inadequate to take into account certain environmental and social issues. Gasparatos et al (2007) note that aggregation tools like cost benefit analysis, have the great advantage of a strong theoretical foundations in economic theory but they can be inadequate in certain situations as progress towards sustainability goes beyond economic efficiency to include equity considerations. Similarly, Cavanagh et al (2007) point out that monetisation predominantly relies on assumptions and discount techniques that focus on absolute figures disregarding the importance of subjectivity and perceptions.

The development and integration process of indicators is hindered further by the shift in the social sustainability discourse from the in-depth analysis of hard themes towards the inclusion of soft themes, as reviewed earlier. As a result, new sustainability indicators are increasingly focused on measuring these emerging themes rather than improving the measurement of more traditional concepts such as equity and fairness. For example, if on the one hand, a growing number of variables and factors are being proposed to deconstruct and measure happiness and well being of individuals and communities worldwide (Veenhoven, 2002; Veenhoven and Hagerty, 2006), on the other, the main approach to equity still relies on the analysis of income and relative prosperity, as shown for example by recommendations contained in the UK Green Book (HM Treasury, 2005), a recent guideline document for the appraisal of governmental policies, plans and projects.

Recent sets of sustainable development indicators also illustrate the tendency of favouring the investigation of softer themes at the expenses of sophisticating the measurement of more established social sustainability pillars. For instance the latest set of sustainable development indicators released by the UK government in 2007 (ONS and DEFRA, 2007) contains a Sustainable Communities and a Fairer World cluster of indicators, addressing social sustainability concerns. This cluster suggests several indicators to assess different aspects of sustainable communities, including well-being, life satisfaction etc. However, it does not recommend any index to deal with the interlinked subjects of social justice, equity, fairness, and cohesion (ONS and DEFRA, 2007: 96). Similarly, a recent study commissioned by the EU Parliament (EP, 2007) to look at the implementation of the Sustainable Communities approach in the EU concluded that fairness cannot be adequately measured through existing indicators and further work is needed in this area.

5. Social Sustainability Practice: The City of Vancouver

Several theoretical frameworks have been suggested by scholars to assess social sustainability for example in the context of policy scenarios (Oman and Spangenberg 2006) and the analysis of the globalisation (Koning 2001), but these have never been mainstreamed or applied empirically. By contract, Vancouver municipal authorities enacted in 2005 a Social Development Plan (2005, simply called SDP for the remainder of this section) for the city and developed an ad hoc Social Sustainability Framework. The latter is the first of its kind to be applied in practice at city level, and thus, it has been selected for the purpose of this paper.

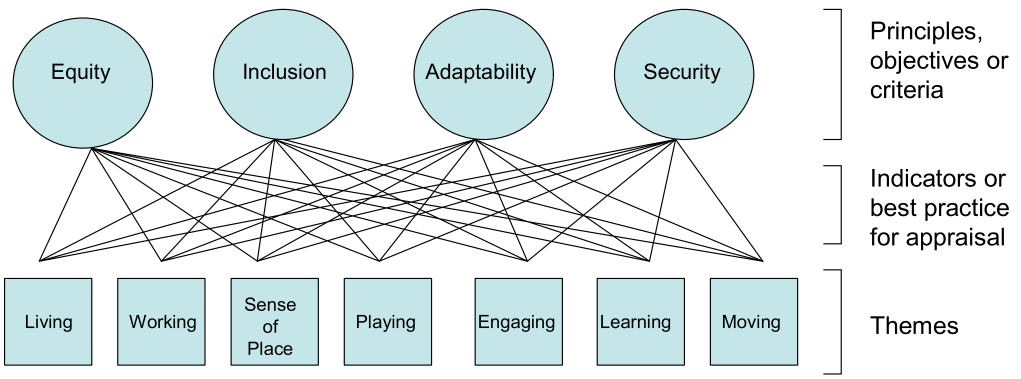
In Vancouver's SDP, social sustainability is defined as follows:

For a community to function and be sustainable, the basic needs of its residents must be met. A socially sustainable community must have the ability to maintain and build on its own resources and have the resiliency to prevent and/or address problems in the future (City of Vancouver, 2005 : 12).

According to the Plan, the main components of social sustainability are basic needs, individual capacity and social capacity. Individual capabilities are linked to education, skills, health, values and leadership whilst community capabilities stem from relationships, networks and norms facilitating collective action.

Figure 2 illustrates how the purse of these overarching milestones of social sustainability is guided by four principles and policy actions in seven areas or themes. The principles include equity, inclusion, adaptability and security. Most specifically equity is intended as access to sufficient resources to participate fully in community life and as sufficient opportunities for personal development and advancement; social inclusion and interaction means involvement in setting and working towards collective community goals, which is fostered by ensuring that individuals have both the right and the opportunity to participate in and enjoy all aspects of community life; security allows individuals and communities to have economic security and have confidence that they live in safe, supportive and healthy environments. The Plan argues that until people feel safe and secure, they are unable to contribute fully to their own well-being or to engage fully in community life. Lastly, adaptability is intended as the resiliency for both individuals and communities and the ability to respond appropriately and creatively to change (City of Vancouver, 2005).

Figure 2: Framework for social sustainability assessment in Vancouver



Source: Elaborated from GVRD (2004, 2004a) and City of Vancouver (2005)

Figure 2 shows how these four overarching principles provide guidelines to achieve sustainability in seven themes, ranging from 'living' to 'moving'. Indeed, a guide to the implementation of the framework (GVRD, 2004), identifies the characteristics required to 'live', 'work', 'play' etc. in an equitable, inclusive, safe and adaptable manner. The in-depth analysis of these requisites is, however, outside the scope of this paper. Here it suffices to pinpoint the fundamental guiding role played by principles and themes in social sustainability frameworks and the importance of the selection of social sustainability indicators.

Indeed, the interrelationships between principles and themes, underpinning the progress towards a socially sustainable Vancouver are monitored through a set of urban and regional sustainability indicators that draw upon expert-based and citizen-based recommendations, which are gathered also through the work of the Regional Vancouver Urban Observatory initiative (Holden, 2006). The selection of sustainability indicators, however, is still a work in progress but it is expected to build mainly on Quality of Life of Indicators developed by the Federation of Canadian Municipalities, which are summarised in the Appendix. In local authorities' views, quality of life indicators provide an overview of changes and trends in society and can therefore offer a unique insight into its sustainable development.

This approach to social sustainability by the city of Vancouver highlights the importance of establishing guiding principles, themes and indicators through which the social sustainability performance of cities can be assessed in partnerships with the city inhabitants themselves. In addition, it illustrates how a 'reductionist' approach to sustainability is currently being preferred by some local authorities for practical reasons. According to this approach, the dimensions of sustainable development or the components of social sustainability should be addressed and measured discretely rather than in an integrated fashion.

6. Conclusions

This paper has shown how new 'soft' themes, such as happiness, well-being and social capital, are becoming central to the social sustainability debate, together with more traditional 'hard' concepts of basic needs , equity, employment etc. If on the one hand this sophistication mirrors the changing social needs of individuals and communities, on the other it is adding complexity to the interpretation and measurement of social sustainability. Indeed, at present, there is disagreement concerning the main underlying themes and objectives of social sustainability as these changes according to diverging worldviews, study perspectives and discipline-specific criteria amongst social scientists.

The taxonomical division between traditional and emergent social sustainability themes and indicators proposed in this paper is instrumental to suggest that the shift toward the analysis of more elusive concepts in the social sustainability debate may continue for the foreseeable future as larger sectors of communities and societies become more affluent and less worried about the satisfaction of basic needs. It is important however that this new focus on emerging themes is not pursed at the expense of more in-depth analysis of traditional pillars of social sustainability, such as equity and poverty, which have received less attention in recent social sustainability works.

The paper has also illustrated how the progress toward sustainability is increasingly being appraised by extending and integrating 'Impact Assessment' and 'Strategic Impact Assessment' methods into 'sustainability assessment'. Techniques such as Environmental Impact Assessment, Strategic Environmental Assessment, Social Impact Assessment, Health Impact Assessment etc. are being amalgamated into a new independent form of assessment rooted in the philosophical and methodological framework provided by sustainability. However, these early forms of impact assessment were not designed to address the complexity inherent to the measurement of sustainability. As a result, there is widespread uncertainty concerning for example how different typologies of impact and assessment techniques should be integrated together.

For these reasons, at present, various typologies of sustainability assessment (e.g. social, economic and environmental) can still be discerned as shown by the social sustainability framework designed by the City of Vancouver, which is the first ad-hoc framework to be implemented at policy level, as pointed out earlier. The analysis of this framework has shown the fundamental role played by principles, objectives and themes in assessing the social dimension of sustainable development. Further, it has highlighted the importance of the selection of indicators to monitor the framework. In this context, this paper has pointed out a few of the methodological and theoretical quandaries concerning sustainability indicators, including for example (i) the need to improve the neglected measurement of traditional social sustainability themes before addressing emerging concerns, and (ii) the choice of most suited metrics (e.g. single or composite indexes etc).

Future research will have to focus on unravelling the underlying inter- and intra-linkages between social sustainability themes (for example equity and happiness or well-being and identity etc.), principles and objectives. Further, it will have to investigate how these can be 'quantified' using simple and user friendly methods capable of deconstructing and monitoring these elements without losing the richness of information that is embedded within them.

References

Ancell S. and Thompson-Fawcett (2008), The Social Sustainability of Medium Density housing: A Conceptual model and Christchurch Case Study, Housing Studies,(23):3, 423-442

Assefa G. and Frostell B., (2007), Social Sustainability and Social Acceptance in technology Assessment: A Case Study of Energy Technologies, Technologies in Society (29): 63-78

Baines J. and Morgan B., (2004), 'Sustainability Appraisal: A Social Perspective' In Sustainability Appraisal. A Review Of International Experience And Practice, Dalal-Clayton B And Sadler B, (Eds), First Draft of Work in Progress, International Institute for Environment and Development, London

Barrow, C. J., (2000), Social Impact Assessment. An Introduction, Arnold, London

Biart, M. (2002) 'Social sustainability as part of the social agenda of the European community', in Ritt, T. (Ed.): Soziale Nachhaltigkeit: Von der Umweltpolitik zur Nachhaltigkeit? Arbeiterkammer Wien, Informationen zur Umweltpolitik 149, Wien, pp.5–10. Available at

http://wien.arbeiterkammer.at/pictures/importiert/Tagungsband_149.pdf

Bramley, G., Dempsey, N., Power, S. and Brown, C., (2006) What is 'Social Sustainability' and How do our Existing Urban Forms Perform in Nurturing it?, Paper presented at the 'Sustainable Communities and Green Futures' Conference, Bartlett School of Planning, University College London, London.

Burton, E., (2000), The Compact City: Just or Just Compact? A Preliminary Analysis, Urban Studies, 37, 11, 1969-2001

Cavanagh J.A., Frame, B. R., Fraser, M., Gabe,. G., (2007), Experiences of applying a sustainability assessment model, International Conference on Whole Life Urban Sustainability and its Assessment, SUE-MoT Conference Proceedings Glasgow, UK 27–29 June

Chambers R and Conway G (1992) Sustainable rural livelihoods: Practical concepts for the 21 st century IDS Discussion Paper 296, IDS, Brighton

City of Vancouver (2005), A Social Development Plan for the City of Vancouver: Moving Towards Social Sustainability, Administrative Report A7, Vancouver

Coglianese, C. (1999). The limits of consensus. The environmental protection system in transition: Toward a more desirable future. Environment, (41) 1–6

Chiu R. L. H., (2003, Social Sustainability, Sustainable Development and and Housing Development: the Experience of Hong Kong, in Forrest R. and Lee J. (Eds), Housing and Social Change: East-West perspectives, Routledge, London

Colantonio, A., (2007) Social Sustainability: An Exploratory Analysis of its Definition, Assessment Methods, Metrics and Tools, OISD (EIB) WP No 1

Dalal-Clayton B. and Sadler B., (2005), Sustainability Appraisal – A Review of International Experience and Practice, Earthscan Publications, London

Department for International Development (DFID), 1999, Sustainable Livelihoods Guidance Sheets, London

Drakakis-Smith D., 1995, "Third World Cities: Sustainable Urban Development, 1", Urban Studies, Vol. 32, Nos 4-5,

Egan, J., (2004), The Egan Review: Skills for Sustainable Communities, ODPM, London

Elkington, J (1994) "Towards the sustainable corporation: win-win-win business strategies for sustainable development," California Management Review, Winter 90-100

European Commission (EC), (2005), Sustainability Impact Assessment, available at http://ec.europa.eu/trade/issues/global/sia/faqs.htm

European Parliament (EP), (2007), The Possibilities For Success Of The Sustainable Communities Approach and its Implementation, European Parliament Study Directorate-General For Internal Policies Of The Union Structural And Cohesion Policies Policy Department

European Union, Regional Policy Inforegio, (2003), Evaluating Socio Economic Development, Sourcebook 2: Methods & Techniques, Brussels

Gasparatos, A., El-Haram, M., Horner, M., (2007), The argument against a reductionist approach for assessing sustainability, International Conference on Whole Life Urban Sustainability and its Assessment, SUE-MoT Conference Proceedings Glasgow, UK 27–29 June

Gasparatos A., El-Haram M., Horner M. (2008), A Critical Review of Reductionist Approaches for Assessing the Progress Towards Sustainability, Environmental Impact Assessment Review (28): 286-311

George, C., (2001), Sustainability appraisal for sustainable development: integrating everything from jobs to climate change, Impact Assessment and Project Appraisal, 19: (1), 95 – 106.

Gibson RB, Hassan S, Holtz S, Tansey J, Whitelaw G. (2005), Sustainability Assessment: criteria, processes and applications. London: Earthscan;

Glasson, J. (2001), Socio-economic impacts 1: overview and economic impacts, chapter 2 in Methods of Environmental Impact Assessment, Therivel R., and Morris P., (ed), 2nd edition, UCL, London

Glasson, J. and Gosling, J. (2001), SEA and regional planning – overcoming the institutional constraints: some lessons from the EU. European Environment. 11 (2): 89-102

Glasson J, Therivel R, Chadwick A. (2003), Introduction to environmental impact assessment: principles and procedures, process, practice and prospects. London/Philadelphia: UCL Press

Glasson J. and Wood G., (2008) Urban Regeneration and Impact Assessment for Social Sustainability, paper presented at the IAIA08 Conference, Perth, Australia

Great Vancouver Regional District, (GVRD), (2004), The Social Components of Community Sustainability: A Framework, TAC Social Issues Subcommittee, Vanvouver

--------- (2004a) The Social Components of Community Sustainability: A Framework User's Guide , TAC Social Issues Subcommittee,

Hacking T., and Guthrie P., (2008), A framework for clarifying the meaning of Triple Bottom-Line, Integrated, and Sustainability Assessment, Environmental Impact Assessment Review 28 (2-3) 73–89

Hans-Boeckler-Foundation (Ed.) (2001), Pathways towards a sustainable future, Setzkasten, Düsseldorf.

Hardoy J., Mitlin D. and Satthertwaite D., (1992), Environmental Problems in Third World Cities, Earthscan Publications, London

Hens L., and De Wit J. De, (2003) The development of Indicators for Sustainable Development: a State of the Art Review, International Journal of Sustainable Development (6) : 436-459

HM Treasury, (2005), The Green Book, Treasury Guidance, TSO, London

Holden M., (2006), Urban Indicators and the Integrative Ideals of Cities, Cities (23):170-183

Imperial College Consultants (2005), The relationship between the EIA and SEA Directives, London

International Association of Impact Assessment (IAIA), 2003, Social Impact Assessment International Principles, Special Publication Series No. 2

Keirstead, J., (2007), Selecting sustainability indicators for urban energy systems, International Conference on Whole Life Urban Sustainability and its Assessment, SUE-MoT Conference Proceedings Glasgow, UK 27–29 June

Koning, J., (2001), Social Sustainability in a Globalizing World. Context, theory and Methodology Explored, paper prepared for the UNESCO/MOST Meeting, 22-23 November 2001, The Hague, the Netherlands

Land Use Consultants (LUC) and the Royal Town Planning Institute (RTPI), 2008, Issues for the Practice of Sustainability Appraisal in Spatial Planning – a Review, prepared for the Sustainable Development Research Network (SDRN)

Large Urban Distressed Areas (LUDA), (2006), Compendium, available at http://www.luda-project.net/compendium.html

Layard, R., (2007), Against Unhappiness, Prospect (on line-version), 137

Lee N. (2002), Integrated approaches to Impact Assessment: substance or make-believe? Environmental Assessment Yearbook. Institute of Environmental Management and Assessment/EIA Centre. Lincoln/ Manchester: University of Manchester; p. 14–20

Littig, B. and Grießler, E., (2005) International . Journal of Sustainable Development, Vol. 8: 1/2, 65-79

Metzner, A. (2000), Caring Capacity and Carrying Capacity - A Social Science Perspective, Paper presented at the INES 2000 Conference: Challenges for Science and Engineering in the 21st Century, Stockholm

OECD, (2001), Analytic Report on Sustainable Development SG/SD(2001)1-14, OECD, Paris

Office of National Statistics (ONS) and Department for Environment Food and Rural Affairs, (DEFRA), 2007, Sustainable Development Indicators in Your Pocket, Defra Publications, London

Omannn I. and Spangenberg J.H., (2002) Assessing Social Sustainability. The Social Dimension of Sustainability in a Socio-Economic Scenario, paper presented at the 7th Biennial Conference of the International Society for Ecological Economics" in Sousse (Tunisia), 6-9 March 2002

Ormerod, P. and Johns H, (2007), Against Happiness, Prospect (online version), 133

Polese, M. and Stren, R,. (Eds.), (2000) The Social Sustainability of Cities: Diversity and the. Management of Change, University of Toronto Press, Toronto

Pope J., (2007), Sustainability Assessment as a Deliberative Learning Process, presentation at Sustainability Conference, University of Madras, Chennai, India, 4-7 January.

Pope, J., Annandale, D., Morrison-Saunders A., (2004) Conceptualising sustainability assessment, Environmental Impact Assessment Review (24), 595- 616

Rees W.E. and Wackernagel M., (1996), Our Ecological Footprints. Reducing Human Impact on the Earth, New Society Publishers, Canada

Royal Commission on Environmental Pollution (RCEP), (2002) 23rd Report on Environmental Planning, Cm 5459, The Stationery Office, London

Ruddy, T. F., and Hilty M. L., (2008), Impact assessment and policy learning in the European Commission, Environmental Impact Assessment Review, Vol 28, (2-3): 90-105

Rydin Y. and Pennington M., (2000), "Public Participation and Local Environmental Planning: The Collective Action Problem and the Potential of Social Capital", Local Environment, 5 (2): 153-169

Sachs, Ignacy (1999), Social sustainability and whole development: exploring the dimensions of sustainable development. In: B. Egon and J. Thomas, Editors, Sustainability and the social sciences: a cross-disciplinary approach to integrating environmental considerations into theoretical reorientation, Zed Books, London

Saunders A. M. and Therivel R. (2006), Sustainability Integration and Assessment, Journal of Environmental Assessment Policy and Management Vol 8, (3): 281-298

Schmidt, M., Glasson, J., Emmelin, L. and Helbron H., (2008), Standards and Thresholds for Impact Assessment, (eds) Springer, Verlag, Berlin, Heidelberg

Scrase J. I., and Sheate W. R. (2002), Integration and Integrated Apporaches to Assessment: What Do They mean for the Environment?, Journal of Environmental Policy and Planning (4): 275-294

Sheate W. R., Rosario do Partidario M., Byron H., Bina O. and Dagg S., (2008), Sustainability Assessment of Future Scenarios: Methodology and Application to Mountain Areas of Europe, Environmental management (41): 282-299

Sinner, J., Baines, J., Crengle, H., Salmon, G., Fenemor, A., & Tipa, G. (2004), Sustainable Development: A summary of key concepts. Ecologic Research Report No. 2, New Zealand

Spangenberg J.H and Omannn I., (2006), Assessing Social Sustainability: Social Sustainability and its Multicriteria Assessment in a Sustainability Scenario for Germany, International Journal of Innovation and Sustainable Development, Vol 1, (4): 318-348

Stagl S (2007) Emerging methods for sustainability valuation and appraisal - SDRN rapid research and evidence review. London: Sustainable Development Research Network, 66pp

Stewart M. (2001) MMSD life cycle assessment workshop: the application of life cycle assessment to mining, minerals and metals. Centre for Risk, Environment and Systems Technology and Analysis (CRESTA) and Department of Chemical Engineering. London: University of Sydney for the International Institute for Environment and Development (IIED);

Therivel, R. (2004) Sustainable Urban Environment-Metrics, Models and Toolkits-Analysis of Sustainability/ social tools, Levett-Therivel, Oxford

Thin N, Lockhart C. and G. Yaron (2002), Conceptualising Socially Sustainable Development, A paper prepared for DFID and the World Bank, DFID, mimeo

Townsend, I., and Kennedy, S., (2004), Poverty: Measures and Targets, Research Paper 04/23, Economic Policy and Statistics Section, House Of Commons Library, London

United Kingdom Government (2004), Planning and Compulsory Purchase Act , London

United Nations (UN), (2001), Report On The Aggregation Of Indicators Of Sustainable Development. Background Paper For The Ninth Session Of The Commission On Sustainable Development, UN, New York

United Nation Environment Programme, (UNEP), (2004), Assessment of Sustainability Indicators (ASI) A SCOPE/UNEP/IHDP/EEA Project, ASI Workshop. 10-14 May 2004, Prague, Czech Republic

United Nations (UN), (1992) Earth Summit: Agenda 21, The United Nations programme of action from Rio, United Nations, New York

United Nations Conference on Environment and Development (UNCED), (1992), Agenda 21, Earth Summit, UN, 3 - 14 June, Rio de Janerio, Brazil

Van de Kerkhof M., (2006), Making a difference: On the constraints of consensus building and the relevance of deliberation in stakeholder dialogues, Policy Science (39):279–299

Veenhoven R. and Hagerty M. (2006), Rising Happiness in Nations 1946-2004, Social Indicators Research, (79) : 421-436

Veenhoven, R. (2002), Why Social Policy Needs Subjective Indicators, Social Indicators Research, (58) : 33-45

World Bank, (1995), Performance Indicators in Bank-Financed Education Operations: Second Edition, by Sigurdsson S. and Schweitzer E., New York

Acknowledgments

I would like to thank Prof. Tim Dixon (OISD) for his numerous helpful editorial comments, which have significantly improved the structure and the content of this working paper through various drafts. I also wish to thank Prof. John Glasson (OISD) for his valuable suggestions especially concerning the sections examining sustainability assessment and indicators.

Appendix: Vancouver Quality of Life and Social Sustainability Indicators

Demographic Background Information	Affordable Appropriate Housing	Civic Engagement	Community and Social Infrastructure	Education	Employment	Local Economy	Natural Environment	Personal & Community Health	Personal Financial Security	Personal Safety
Population	30%+ Income on Shelter	Voter Turnout	Social Service Professionals	Education Levels	Unemployment / Employment Rates	Business Bankruptcies	Air Quality	Low Birth Weight Babies	Community Affordability	Young Offenders
Foreign Born	Vacancy Rates	Women in Municipal Government	Private Health Care Expenditures	Literacy Levels	Quality of Employment	Consumer Bankruptcies	Urban Transportation	Teen Births	Families Receiving EI/ Social Assistance	Violent Crimes
Visible Minorities	Core Housing Need	Newspaper Circulation	Subsidized Child Care Spaces	Adult Learning	Long Term Unemployment	Hourly Wages	Population Density	Premature Mortality	Lone Parent Families	Property Crimes
Language Spoken at Home	Substandard Units	Volunteering	Social Assistance Allowance	Education Expenditures	Labour Force Replacement	Change in Family Income	Water Consumption	Work Hours Lost	Incidence of Low Income Families	Injuries and poisonings
Population Mobility	Changing Face of Homelessness	Charitable Donations	Outdoor Recreation Areas	Classroom Size		Building Permits	Wastewater Treatment	Suicides	Children Living in Poverty	
New Immigrant Group	50%+ Income on Shelter		Public Transit Costs	Student / Teacher Ratio			Solid Waste	Infant Mortality	Government Transfer Income	
Aboriginal Population	Rental Housing Starts		Social Housing Waiting Lists	Post-Secondary Tuition			Ecological Footprint		Economic Dependency ratio	
Migration	Monthly Rent		Rent-Geared-to-Income Housing	Spending on Private Education			Recreational Water Quality		Government Income Supplements	
Household									Household Income	
Renters & Owners										

(City of Vancouver, 2005)

‘Measuring’ sustainable living agendas

Dr Anne Louise Hurley, Dr Peter Moug, Dr Susan Molyneux-Hodgson, Prof. Richard Ashley, Dr Nicki Schiessel

University of Sheffield, UK

This paper describes the process of developing a novel sustainability assessment methodology for a new urban redevelopment research project. Understanding of the process is drawn from decades of research in the development of sustainability assessment frameworks and in particular those concerning water management and urban development. Parallel research themes in the areas of organisational change, complexity and uncertainty are drawn upon in order to address acknowledged limitations of assessment frameworks for practical decision making. Different interpretations of the notion of sustainability and its assessment amongst researchers at the beginning of a multi-disciplinary urban regeneration project provide a view of the starting point of - and potential barriers to, a transition from disciplinary-focused to integrated and inclusive decision making.

The aims of the work were to:

• devise a framework for understanding and applying commonly agreed sustainability principles to a multi-disciplinary urban redevelopment research project by involving stakeholders and researchers in its construction,

• formulate a means of review and revision of the framework to reflect learning and increased integration throughout the project

• apply the framework to other types of assessment within the project, and

• log the process of framework development in order to better understand how learning and integration came about (or didn't)

The urban redevelopment research project examines interventions into an urban river corridor that aim to produce significant social, economic and environmental gains and hence more sustainable living agendas. The research is divided into 'themes': 'people' (stakeholder engagement and governance processes), 'river' (ecological goods and services), 'design' (possibilities for intervention and innovation) and 'values' (agents of change and measures of success). The work described here was undertaken as part of the values theme. It examines indicators of success utilised within the different themes and provides a structured view of the uncertainty these may generate in terms of holistic sustainability assessment. Implications for planning and management decisions for the perceived sustainable living agendas are considered.

There is an increasing requirement on professionals to demonstrate their efforts towards more sustainable development and to justify and audit their decision making in terms of the environment and society as well as in economic terms. Therefore, frameworks will either evolve or another way of assessing sustainability must emerge. The challenge is how to 'measure' the dynamic process of change to a new way of working - what causes change for the better? Can the causes be understood and transferred to future projects? Within the URSULA project the aim is to at least begin to understand how to use sustainability assessment to assist the transition to a more integrated way of working.

Keywords: decision support, indicators, integration, values, transitions

1 Introduction

1.1 Urban river corridors and sustainable living agendas

The work described forms part of the £2.5 m project: 'Urban River corridors and Sustainable Living Agendas' (URSULA), which is part of the Sustainable Urban Environments (SUE) programme led by the Engineering and Physical Sciences Research Council (EPSRC). The project began on 1st January 2008, involves the Universities of Sheffield, Bradford and Durham and will run for four years. URSULA's hypothesis is that there are *"...significant social, economic and environmental gains to be made by integrated and innovative interventions in urban river corridors".* The project *"tackles river corridor issues holistically by treating the river and its urban setting as a system..."* and *"...will produce innovations, tools and knowledge to help guide the regeneration of urban river corridors worldwide"* (http://www.ursula.ac.uk/).

The URSULA team is working with professional, institutional and academic stakeholders to regenerate the River Don corridor within the city of Sheffield (UK) and is linking urban (master) planning processes with opportunities for innovative, practical and aesthetic use of the river. During the 19th century, the urban stretch of the Don was a major focus for the industrial revolution and much of the adjacent land remains contaminated, industrially derelict and, despite running through the centre of the fourth largest city in England, is largely disconnected from local people.

A central challenge for URSULA is to determine the best ways (economically, environmentally and socially) in which to utilise the river in regenerating the urban environment whilst complying with legislation such as the EU Water Framework Directive (European Parliament and Council of the European Union, Directive 2000/60/EEC) and under conditions of a changing climate. Sheffield was badly affected by flooding in summer 2007, which came as a shock as the first major flooding of the city in 70 years. Over a thousand affected people and losses of £22.5 million reported by Sheffield City Council (BBC 2008) brought into sharp relief the need to build resilience to climate change into future development plans.

In order to consider interventions into the urban river corridor holistically, the URSULA project was arranged around four themes of work: 'People', 'Design', 'River' and 'Values', each with responsibility for the analysis of a set of interventions.

1.1.1 The People theme

This theme investigates aspects of governance and participation in the redevelopment of urban river corridors such as:

- the 'story' of the development of the 'Five Weirs Walk';
- an examination of the Sheffield Waterways Strategy Group for its influence on urban river corridor redevelopment;
- an examination of the River Stewardship Company - an organisation with an interest in assisting businesses and communities to improve the riverside environment;
- URSULA as action research, and
- stakeholder interaction with physical interventions.

1.1.2 The Design theme

The Design theme examines physical interventions such as:

- access improvements;
- integrated urban water management (IUWM)/ Sustainable drainage systems (SuDS);
- deculverting;
- power generation, and
- urban design/landscape improvements.

1.1.3 The River theme

Interventions in the River theme are examples of the re-naturalisation of river channels such as:

- weir modification;
- river restoration, and
- habitat enhancement (terrestrial).

1.1.4 The Values theme

The Values theme mainly works with research led by other themes, including assessment. Key elements of the theme's contribution are to:

- present the interventions through computational visualisation,
- assess the effects of interventions on land and property values,
- develop/use indicators for a broad range of issues relating to urban river corridor regeneration, and to
- co-ordinate the assessment of interventions at project level.

Broad interventions are also included in this theme, which are:

- masterplanning using 'Blue-green-grey corridors', and
- visualisations.

New methods for the facilitation of collaborative discourse are being tested through the development of computer generated, 3-D visualisations of places, which involve residents, employees, employers, professionals and other local stakeholders in dialogue about their aspirations for the urban physical environment. Specific local area interventions are being developed, with a series of alternative masterplans for local places to integrate a range of physical and non-physical interventions such as sustainable drainage systems (SuDS), flood alleviation channels and access improvements. The types of interventions that can be considered are limited by resources, but allow for detailed qualitative and quantitative examination of the social, economic and environmental impacts of each as a 'building block' in river corridor redevelopment (Ashley et al. 2008).

1.2 The indicators task

In addition to the themes, URSULA comprises a set of twelve tasks, one of which is the development of a set of criteria and indicators of intrinsic and extrinsic values that will support a holistic, integrated sustainability assessment of the interventions.

The team of people undertaking the task of criteria and indicator development for the assessment of URSULA interventions is multi-disciplinary, with expertise in engineering, environmental and political science and sociological studies. The team also necessarily interacts with all other tasks being undertaken as part of the broader project, comprising academic expertise in landscape design and planning, environmental and water engineering, structural design, architecture, IT, economics and ecology as well as a range of professional project partners (see http://www.ursula.ac.uk).

This thesis of URSULA is based on some means to show that ‘there are significant social, economic and environmental gains to be made by integrated and innovative interventions in urban river corridors.” Tested via assessment of the “portfolio of interventions, tools and supporting evidence for the redevelopment of urban river corridors to create “places where people want to live, work and visit, now and in the future”.

There is a danger that because the original hypothesis separates the three pillars of sustainability that there will be insufficient integration and assessment of the consequential ‘push-pulls’ of changes in one sphere impacting on another. Furthermore this may create problems of scales and boundaries; although URSULA is focused on the Don River corridor, any interventions would have much wider implications, which should overall enhance the ‘liveability’ of the City of Sheffield and at the same time not detract from this elsewhere. The 'liveability enhancement' should also follow the principle of intra and inter-generational equity

Therefore there is a requirement to define both an overall framework in which URSULA can address the question as to whether or not there have been, or will be, long-term ‘improvements’ as a result of any URSULA interventions and also the components whereby these improvements can be 'measured', whilst recognising that many important sustainability factors cannot be quantified.

There are no approaches to sustainability assessment that are free from pre-conceived values on the part of those undertaking the assessment. Nevertheless, most recent ideas about sustainability assessment tools, techniques and paradigms, have concluded that formalised frameworks and structures can be useful primarily as part of the process of discourse between the stakeholders engaged in the sustainability assessment (Hurley et al., 2008). There are no objective ways to assess sustainability, especially as we still do not know what sustainable human systems actually look like, now or in the future.

2 Methods

2.1 Sustainability in URSULA

The approach taken has been first to attempt to deconstruct the project in terms of sustainability, to attempt to reach consensus across the teams making up the research group as to the aim of sustainability assessment, then to define how, where and what indicators fit in, what they are needed for and what they should comprise.

There are three distinct aims of URSULA and these are interpreted relevant to the formulation of sustainability indicators in Table 1.

Table 1: The aims of URSULA interpreted for relevance to indicators of sustainability assessment

URSULA aims	Relevance to indicator formulation
1. To understand the current values and potential future values of the benefits of urban development: to gather the evidence	The terms 'Current' and 'future' form broad temporal boundaries Means of demonstration of evidence of the 'values' and 'benefits' of urban redevelopment are required
2. To propose how we can move from current to future values by innovation in urban design	An innovation-centred perspective is the premise
3. To identify how stakeholder interactions (associated with market, governance or research processes) impact on river corridor redevelopment	Because URSULA is an intervention in its own right, identification of stakeholder interactions also means influencing those interactions

The initial deconstruction showed that URSULA is concerned with the wider vision of sustainability and not simply a set of ‘criteria and indicators’ as may be inferred from the stated aim of the indicators task. Relating the aims of the project to sustainability indicators illustrates how the assessment of sustainability depends on temporal and spatial boundaries and an understanding of the formation of values both within and outwith the project.

The question of boundaries is particularly relevant between utility sectors such water, energy, transport and resource use (Ashley et al., 2008). Most approaches to sustainability assessment have so far been sectoral (e.g. Kapelan et al., 2005) with few attempts at the integration that would be useful for assessing urban area change during the redevelopment process. Decision support tools available for sustainability assessment also tend to lack systematic risk and uncertainty models and good use of visualisation techniques to support deliberative, discussion led dialogue between stakeholders. The former is significant in light of socio-economic and climate change and the latter for communication, group decision making and explicitness in value judgements. The methodology developed as part of URSULA aims to address these drawbacks.

2.2 Sustainability assessment frameworks

The challenge of comparing the relative sustainability of different options has regularly been met by the development of assessment frameworks as a decision-making support tool. This is typically done by specialists seeking to enhance the explicit incorporation of sustainability into decision making processes. It is also used to provide means for the stakeholder community to understand their issues and to contribute their judgement and views (e.g. Munda, 2004, Makropoulos et al., 2008). However, the limitations of assessment framework in facilitating development that is more sustainable lie within the inadequacies of the frameworks themselves for describing the context (Stagl, 2007), as well as the lack of institutional capacity to employ them as intended (Hurley et al., 2008). The development of a comprehensive framework of assessment was however felt by the research group to be appropriate for URSULA in order to give structure and reference to the disparate tasks at work.

Examining how, why and where sustainability is being assessed has comprised a review of what others have been doing (within the various SUE consortia and beyond), how sustainability assessment is being handled within the 'normal' development planning processes in England, and the trajectory of sustainability assessment from a social science perspective.

From this work it was concluded that although there are some new ideas about sustainability assessment based on Integrated Assessment (IA) (Weaver and Rotmans, 2006) practical applications continue to use a reductionist process, based on the Principles, Objectives, Criteria, Indicators and Attributes (POCIA) framework.

The POCIA framework is a common means of taking the complex (and still contested) concept of sustainability and breaking it down into manageable, usable components that are relevant to the experts who have been tasked with applying the concept within their work. The framework set out in Table 2 will enable consistent data collection and will be used to compare emerging intervention options against criteria common to all interventions. Ultimately, it will be used to evaluate scenarios for case study sites. However, it is important to note that sustainability appraisal is a process as well as a product. A key function of the framework will be to facilitate ongoing communication between researchers regarding the effects of their emerging options on a range of criteria. As such it facilitates a holistic, integrated approach to option development.

Table 2: The Principles, Objectives, Criteria, Indicators, Attributes (POCIA) assessment framework as applied to URSULA (after Ashley et al., 2004 and Ashley et al., unpublished)

Principles	Principles are normative definitions/goals for sustainability which aspire to a universal validity that can be agreed upon by all. They are necessarily abstract and idealised. The boundaries of assessment in space and time should be agreed at this level. These guiding principles are typically operationalised through selecting more specific criteria and indicators. For the purposes of URSULA, the UK principles of sustainable development have been adopted: - Living within environmental limits - Ensuring a strong, healthy & just society - Achieving a sustainable economy - Using sound science responsibly - Promoting good governance (www.sustainable-development.gov.uk)
Objectives	These form a clear set of definitions of anticipated project outcomes. The URSULA objectives have been defined, broadly, as to identify social, economic and environmental gains to be made by integrated and innovative interventions in urban river corridors. The Sustainability Objectives of the Sheffield Development Framework (Sheffield City Council, 2007), broadly categorised as Social, Environmental or Economic, have been used as a basis for developing primary criteria applicable to URSULA. It should be noted that categories are not mutually exclusive

Criteria	These are collectively agreed factors used to assess which of a range of options offers the greatest contribution to achieving sustainability objectives. All criteria must be considered for each and every intervention: it is only possible to compare the relative sustainability of different interventions by using the same criteria. Secondary or sub-criteria can be defined within the URSULA tasks provided these can be assimilated to inform the collectively agreed (primary) criteria. Not all secondary criteria will apply to all task activities. It should be noted that the framework should be seen as a process, not a product, and there is a need for criteria (as well as their linked indicators) to be flexible and dynamic to reflect drivers. The framework should therefore evolve alongside the project as new issues come to the fore.
Indicators	Indicators can be used as a measure of the past and current status of specific criteria, and may be used to set standards against which future performance can be assessed. They may be quantifiable or qualitative assessments and may be spatial or temporal.
Attributes	Attributes are the units of measurement (if any) of the indicators.

2.3 Different perspectives on sustainability assessment

The development of urban river corridors provides an ideal opportunity to enhance ecological quality, which is defined in URSULA as the overlap between the societal demands (including potential future options) for 'ecosystem services' and the sustainable provision of those services. Ecosystem services may include for example drinking water provision, flood mitigation, water purification, recreation, education, nutrient cycling and habitat provision. Traditional management strategies, especially in urban areas, have tended to focus on selected services in isolation; a more integrated approach would consider the interdependencies and potential threshold behaviours among different ecosystem service systems. Design interventions often impact on the ecology of riverine and riparian species with little understanding of how individual ecosystem services and the interrelationships between them are affected (Maltby, unpublished). The achievement of good ecological quality within designed river corridors is seen as reliant on this knowledge.

The ecosystem services approach has emerged as a particular means of drawing relations between nature and society. However the question remains whether key concepts emerging from natural science can be aligned with those generated from social science despite seemingly advancing towards similar ends (i.e. 'sustainability') (Hodgson et al., 2007). Economic approaches have regularly been used to unite the two disciplines, but often neglect crucial parts of an integrated and dynamic system (Winkler, 2006). Recognition of the two-way process is required that acknowledges anthropogenic activity as a major driver of ecosystem change, and that economic development often comes with environmental cost. The challenge is to manage ecosystems in such a way that service provision is sustainable and socially just (Hodgson et al., ibid.).

Another major challenge in creating an assessment framework for URSULA is the inclusion of meaningful social indicators. Research in the field of social indicators is highly generic and is described by the journal Social Indicators Research as 'dealing with problems related to the measurement of all aspects of the quality of life'. In common with the concept of sustainability, quality of life or (more recently) well-being are highly contested ideas (Molyneux-Hodgson, unpublished). The origins of the social indicators movement in the 1970s were largely in response to the success of economic approaches to collating information and as a route to informing fiscal policy development. It was felt that a system of social indicators would help in the development of social policy. Drawbacks acknowledged include the requirement to construct a general theory of a good society that would be acceptable to all (Michalos, 1997) - which is clearly not achievable.

Hodgson et al. (2007) consider implications for potential interdisciplinary collaboration in the study of ecosystem services in the future and suggest collaborative elaboration of the concept from different epistemological points of view. In this way, the ecosystem services approach may serve to become '*…a way forward for natural and social scientists together to explore the world and effect change*'.

2.4 Transitions theory

In creating and using the framework for URSULA, an iterative approach is used to capture the dynamics of sustainability assessment (as a process rather than a product). In this way the elements of a 'transition' from disciplinary to inter- (or even trans-) disciplinary research and application to complex systems such as the urban river corridor may be mapped.

A transition is a structural change in the way a societal system operates; it is a long-term process (the whole process can typically span 25–50 years) resulting from the co-evolution of cultural, institutional, economic, ecological and technological processes and developments at various scales (Rotmans et al. 2000 cited in van der Brugge et al., 2005). Transitions theory offers analytical tools for structuring and explaining the dynamic behaviour of societal systems such as transport, energy supply, agriculture, or water management. The theory emerged from work with complex adaptive systems; a transition process is a fundamental and irreversible change in a system. Transitions are often represented as s-shaped curves, based on a concept of the diffusion of new technology.

There are four phases to the curve (Figure 1). In the pre-development phase, there is concern with design details and the broader institution does not visibly change. In the take-off phase, the system starts to shift, and new technology is supported by development investment. If this stage is successful, there is a faster phase where new players become involved in the uptake and application of the new technology. This momentum can be maintained if the technology is accepted easily or resistance is managed well. It becomes mainstreamed when the pace of institutional change starts to slow down and a new equilibrium is reached.

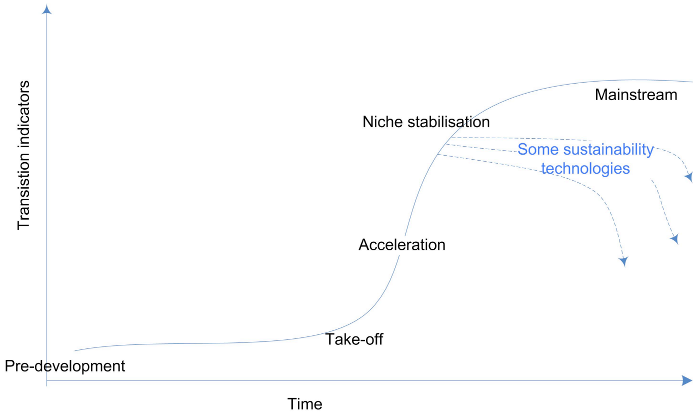


Figure 1: The S-shaped transition curve illustrating the shift between two dynamic equilibria that can be described by a set of system indicators. After van der Brugge et al. (2005)

Historical examinations of transitions (e.g. van der Brugge et al., 2005, Geels, 2006, Brown and Clarke, 2007) have provided clues as to what constitutes system indicators that can show transitions in action, for example in the widespread uptake of urban sewerage systems. The URSULA project can be seen as within the take-off/acceleration phases of a transition to more sustainable urban living agendas. The dynamic factors that positively contribute to the move from disciplinarity to inter-disciplinarity will be identified and incorporated into the continually evolving assessment framework.

2.5 The proposed framework and iterative approach

In URSULA, as the project is focused on the Don and Sheffield it is the Sheffield City Council masterplan that provides the principles and objectives. The masterplan sits within national guidelines from the Communities and Local Government Department and Regional perspectives. As a means of progressing the tasks, the principles and objectives stated in these national and local level documents have been adopted initially for sustainability assessment. The UK Government's principles for sustainable development are outlined in Table 2 and examples of the primary criteria for assessment drawn from Sheffield City Council's (SCC) Development Framework sustainability aims are given in Table 3.

Each of the URSULA research teams has provided indicators used within their field of expertise that have been incorporated into an overall framework for iterative review. The indicators proposed by each team have been allocated to sub-criteria, forming an early iteration of the whole framework in which gaps and inconsistencies are open to debate. Some examples of the indicators and how these are aligned with the criteria of sustainability are given in Table 3.

The complete framework currently comprises 14 primary criteria, each with numerous secondary criteria. It identifies gaps and gives transparency to the areas of sustainable development considered by SCC Development Framework but not addressed by URSULA, as well as the ways in which the project is innovative beyond the confines of the framework. This enables a holistic review of the indicators used by each team in terms of the broad sustainability agenda and consideration of how the dynamics and integration of the project may be best recorded.

Table 3: Examples of the sustainability aims of Sheffield City Council's Development Framework re-interpreted as sustainability criteria, and indicators of criteria fulfilment proposed by URSULA researchers

Primary criteria	Secondary criteria	Indicators	Attributes	Broad sustainability categories (social, economic, environmental)
Waste and emissions management	Material efficiency	Amount of new and recycled reused materials or energy intensive materials	Kg, CO_2, mg/l or %	Environmental
Physical infrastructure efficiency	Profitability	Yield	£	Economic
Effects of governance structures and processes	Democratic credentials of governance in urban river corridor	Quality of political / democratic processes benchmarked against ideal of democratic engagement	Qualitative assessment.	Social

2.6 Framework application

Iterative application of the framework to URSULA interventions will continually refine the details. Understanding this dynamic process of redefining will enable transparency in sustainability assessment. Using the 'physical infrastructure efficiency' primary criterion as an example (Table 3), assessment of the already implemented Five Weirs Walk intervention would require consensus among stakeholders about its boundaries. The walk itself does not directly generate profit, so the secondary criterion 'profitability' may not be considered relevant. Local businesses, however, may experience increased profit as a direct result of the intervention and profitability may be seen as noteworthy. The spatial boundary of its assessment may be within a short distance of the walk or may extend further; the temporal boundary may be over a period of months or years. Which of the framework's secondary criteria are utilised and how, will depend on the stakeholders involved and their concerns at the time of assessments. This approach recognises change and learning processes and enables transparent discussion regarding trade-offs.

It is proposed that acknowledged tensions in the use of assessment frameworks are addressed by periodic review and adjustment of the framework. Minimal change to principal criteria is envisaged, but with more significant changes to the sub-criteria and related indicators. The issues arising in the development of the approach to date have raised interesting research questions about principle, practice and the dynamics of criteria; these will be examined further as the process unfolds.

It is anticipated that the project will be able to explore the trade offs between different issues and interests, using varying combinations of interventions and importantly to refine these options as a way of investigating whether it is possible to develop 'win-win-wins' that is, maximising social, economic and environmental gains for different people. In this respect, the approach can be seen as being similar to the Neighbourhood Initiatives Foundation's Planning for Real © approach (see http://www.nif.co.uk/aboutus/), and building on the UK Commission for Architecture and the Built Environment's Spaceshaper approach to understanding how space works for different stakeholders, before attempting to make changes (CABE, 2007). But it is considered that the visual representation of this information using up-to-date models should support a deliberative, discussion-led dialogue between stakeholders. Of course, in a world of limited resources, it is recognised that in reality there will always be winners and loses, and trade-offs. However, by using this 'envisioning' process, it should be possible to identify opportunities for mutual interests and shared gains associated with multi-functional land uses.

3 Discussion

Different disciplines over many years have built up recognised procedures, which when followed are respected as thorough, defensible methodologies. Sustainability assessment, being as it is multi- or even trans-disciplinary, has no such regulations in place; its robustness is currently being tested. There is an increasing requirement on professionals to demonstrate their efforts towards more sustainable development and to justify and audit their decision making in terms of the environment and society as well as in economic terms. Therefore, frameworks will either evolve or another way of assessing sustainability must emerge.

It is no longer acceptable to take a purely technocratic approach to sustainable development. Different world views expressed by different disciplines, professions and cultures must find a means of expression in robust sustainability assessment. Only by finding outlets for the plurality of perspectives can we hope to generate sound evidence for change and influence policy formation processes (Hodgson and Irving, 2007).

The black box approach of rigid frameworks, tick boxes, building big projects without engagement or post project monitoring, and reliance on the most cost-effective option is 'out'. 'In' is flexibility in approach, being open to new ideas and the opinions of lay persons, trying numerous small ideas and abandoning those that don't work, admitting when we're wrong and learning from it, and being aware of the potential effects on future generations and on the world outside our development/region/country

The challenge is how to 'measure' the dynamic process of change to a new way of working - what causes change for the better? Can the causes be understood and transferred to future projects? Within the URSULA project the aim is to at least begin to understand how to use sustainability assessment to assist the transition to a more integrated way of working.

Acknowledgements

This paper is based on work undertaken as part of a collaborative research programme on Urban River Corridors and Sustainable Living Agendas (URSULA) funded by the Engineering and Physical Sciences Research Council (grant number EP/F007388/1). The authors are grateful for EPSRC's support. The views presented in the paper are those of the authors, and cannot be taken as indicative in any way of the position of URSULA colleagues or of EPSRC on the subject. All errors of fact and interpretation are similarly those of the authors alone.

References

Ashley R M., Moug P., Wild T., Hurley A L., Molyneux-Hodgson S. (2008). Assessing sustainability for urban regeneration in a river corridor - accounting for climate change. Proc. 2008 International Low Impact development conference, Seattle, Washington. 16-19/11/08. EWRI/ASCE.

Ashley, R., Blackwood, D., Butler, D. and Jowitt, P. (2004) Sustainable Water Services: A procedural guide. IWA publishing, London. ISBN: 1 84339 065 5

Ashley, R., Molyneux-Hodgson, S., Moug, P., Hurley, L. and Wild, T. (unpublished). A proposed approach for URSULA in dealing with sustainability assessment. URSULA internal document.

BBC (2008) "Councils' flood cost set at £237m" BBC News http://news.bbc.co.uk/1/hi/england/south_yorkshire/7452170.stm Published 24/06/2008.

Brown, R.R. and Clarke, J.M. (2007). Transition to water sensititve urban design: the story of Melbourne, Australia. Report No. 07/1, Facility for advancing water biofiltration, Monash University, June. ISBN 978-0-9803428-0-2.

CABE (2007). Spaceshaper: a user's guide. Commission for Architecture and the Built Environment, London, England. http://www.cabe.org.uk/publications.aspx

European Parliament and Council of the European Union. Directive 2000/60/EEC of the European Union and of the Council of 23 October 2000 establishing a framework for community action in the field of water policy. Official Journal of the European Communities, 2000, L327/1

Geels, F. (2006). The hygienic transition from cesspools to sewer systems (1840–1930): The dynamics of regime transformation. Research Policy, 35, 1069–1082.

Hodgson S.M. & Irving Z.M. (2007) Policy Reconsidered: Meanings, politics and practices, Bristol: The Policy Press.

Hodgson, S., Maltby, L. Paetzold, A. and Phillips, D. (2007). Getting a measure of nature: cultures and values in an ecosystem services approach Interdisciplinary Science Reviews, 32(3), 249-262.

Hurley A L., Ashley R M., Mounce S. (2008). Addressing practical problems in sustainability assessment Frameworks. Proceedings of the Institution of Civil Engineers Engineering Sustainability 161 March, Issue ES1 Pages 23–3 doi: 10.1680/ensu.2008.161.1.23, Paper 700022.

Kapelan Z., Savic D., Walters G. (2005). Decision support tools for sustainable urban development. of the Institution of Civil Engineers Engineering Sustainability; 158, Sept., Issue Es3 p135-142 paper 14150

Maltby, L. (unpublished) URSULA: Urban River Corridors and Sustainable Living Agendas. Case for Support. River theme, p.6.

Michalos, A. (1997). Combining social, economic and environmental indicators to measure sustainable human well-being Social Indicators Research, 40, 221-258

Molyneux-Hodgson S (unpublished) Review of 'social indicators' as a conceptual device and their relation to other 'indicator frameworks' draft June 2008. URSULA internal document.

Rotmans J, Kemp R, van Asselt MBA (2000) Transitions and transition management, the case of an emission-free energy supply. International Centre for Integrative Studies. Maastricht, The Netherlands

Sheffield City Council (2007). Sheffield Development Framework Core Strategy (Submission Version) - Sustainability Appraisal Report.

Stagl, S. (2007). Theoretical foundations of learning processes for sustainable development. International Journal of Sustainable Development and World Ecology, 2007, 14, (1), 52-62.ADDED

van der Brugge, R., Rotmans, J. and Loorbach, D. (2005). The transition in Dutch water management. Regional Environmental Change, 5, 164–176

Weaver P M., Rotmans J. (2006). Integrated sustainability assessment: what, why, how? Matisse (Methods and Tools for Integrated Sustainability Assessment) Working Papers 1. October. (http://www.matisse project.net/projectcomm/index.php?id=643) (accessed 24/11/08)

Winkler,R. (2006).Valuation of ecosystem goods and services. Part 1: An integrated dynamic approach. Ecological Economics, 59, 82-93.

Diversity, homogeneity or 'just us!': theorising contexts and contents for sustainable inter-community dialogue

Sariya Contractor

University of Gloucestershire, UK

Immigration, a shrinking global village, communication technologies that transcend national boundaries have led to a generation of 'global citizens' who deal with 'difference' on a daily basis. National identity, once a stolid indicator of an individual's or community's loyalties, has become a fluid concept which is permeated by the moveable, overlapping and sometimes antagonistic existences, and affiliations of those who subscribe to it.

In many communities, variations of the 'sons of the soil' or 'local and foreign' debates continue to cast aspersions on those who are deemed 'foreign' and as well as those who are deemed 'local'. Then the integration v/s assimilation discourse implies a real, or is it a reified entity for individuals to integrate or assimilate into. It would be useful to on-going inter-community dialogue to qualify what is 'foreign' and 'local'. It would also be interesting to theorise the nature, tangibility or intangibility of this central entity and any contribution, an understanding of it, could have on the sustainability of social frameworks within urban communities.

Two multicultural societies - India and Britain - with different models of secularism, are trying to resolve issues surrounding the movements of peoples. In India the migration of various rural populations within the country, from different states to Bombay (or Mumbai), the financial capital of the country, is currently creating waves of protests from the local Maharashtrian population. Complaints of 'foreign' exploitation of the city's limited resources and lack of ample opportunity for local people are creating political and social unrest.

In Britain, immigration and it's social, economical and political implications similarly continue to dominate public discourse. There seems to be no correct answer, or perhaps many correct answers, to the question 'What does it mean to be British?'.

Both societies have in the recent past had instances when the social frameworks broke down, groups engaged in rioting and, law and order systems briefly collapsed. In all these cases communities were divided on a difference be it race, religion or origin, yet these were people that had lived together. This indicates the importance of discussion on the sustainability of communities and dialogue within them.

The movement of peoples, their families, their cultures and their identities will increasingly continue to be a part of the changing reality of the demographics of urban communities. It is important as part of discussions on sustainability, not only to plan for the differences between peoples and servicing their varied needs, but also to challenge traditional understandings of communities and to provide for their ever-changing constructs.

Keywords: adaptability, assessment tools, communities, community planning, community sustainability, comparative urban sustainability, culture, identification, integration, socio-cultural structures, sustainability assessment, urban development

1 Introduction

Globalisation and the resultant movement of peoples have created communities characterised by difference. Cultural pluralism and ethno-diversity has almost become the norm, rather than the exception, in most urban and some rural localities. In many communities the presence, the roles, the needs and the *effects* of difference are being debated. Traditional definitions of community, characterising it as a group or association of people, based on physical location, common interests, religious affiliations, race or profession, can no longer describe the dynamic and varied constitutions of contemporary urban communities. And though commonality continues to bring communities together it is difference, which in myriad and multifaceted manifestations must gradually begin to inform and direct discourses about the sustainability of modern communities and cities.

As cities morph into 'sprawling' megapoleis, its populations represent and interact with difference as part of their everyday routines. The more affordable housing options in a suburb invariably become home to upper-middle class white-collar executives who choose to live there because of its proximity to their work in the 'city'. Certain common threads hold the community together but the diasporic variations within such communities are often multifarious - an illustration of the contradiction presented by modernity in cities. The processes of modernity appear to be, on one level, creating modes of order and uniformity within society; however this ordering process also implies the disengagement and disentanglement of human experiences, and *perceived identities* from the ordering process, creating fundamental discontinuities. The orders and structures of modernization, their 'putative totalisations' and overarching generalisations have simultaneously resulted in the fragmentation of everyday experience (Frisby, 2001).

A city is the breeding grounds of community and the formative grounds (Nadarajah & Yamamoto, 2007) for a common culture, traditionally defined as "the complex whole which includes knowledge, belief, art, morals, law, customs, and any other capabilities and habits acquired by man as a member of society" (Taylor, 1958). But can contemporary urban man claim to be a member of a single society? Can he identify a single dominant culture, among the various that he subscribes to, and to which he is more loyal? Which he therefore calls his own. Common culture traditionally a centripetal force holding communities together, is gradually giving way to individualistic interpretations of what is perceived to be 'culture' and which together constitute a centrifugal force which while purporting to hold communities together creates more disparate units within cities.

The movement of peoples towards, already swollen, urban economic hubs creates immediate and practical issues of governance and resource management – local governments have to plan for, create and maintain infrastructures for new jobs, housing, education and health. This paper deals with more pervasive issues that stem from migration. As competition for jobs, homes and resources becomes more intense within urban environments, public dissatisfaction often leads to debates surrounding identity, loyalty and a common shared culture. Without a single shared identity communities must grapple with multiple cultures, varied customs and sometime antagonistic loyalties leading to strife, conflict and in extreme circumstances breakdown in law and order systems.

It is within this context of *movement* and *increasing urban diversity* that this paper will trace the historical and ongoing contexts that contribute to the heterogeneity and identity in modern urban communities. It will argue for inter-community dialogue as one means, for communities to articulate and hence demystify the differences within them. The Global Trends 2025 report predicts that "*in 2025, notions of multi-ethnic 'integration' and value of 'diversity' could face a combination of challenges from nationalists, religious zealots and perhaps some version of a revived Marxist and other class-based or secular ideology*".

In an anthropological sense, a city was invented for exchange – of goods and skills (Mean & Tims, 2005). In the modern urban world this exchange must include exchange of cultures, ideologies and value-systems. Sustainable communities are diverse, reflecting their local circumstance; they should offer a fair, tolerant, inclusive and cohesive environment with a strong local culture and shared community activities (HM Government, 2005).

1.1 Aim and objectives

This paper will explore theoretical and *real* frameworks that define identity, loyalty and community within the contexts of the movement of peoples and resulting urban diversity in the 'developed' and 'developing' world. And aims to present a critical argument for urban diversity and dialogue to be an urgent and integral part of sustainability discourses, urban planning and policy formulation. It will explore current discourses in the public domain as well as in the Academia surrounding immigration and will work towards the following objectives

1. To critically review theories surrounding identity and the movement of people - migration and immigration.
2. To briefly explore current discourses surrounding identity and migration within the context of 'Britishness'.
3. To explore the nature and role of identity politics in the recent clashes in Bombay between the Maharashtrian population and migrants from northern "Hindi speaking" belts
4. To explore inter-community dialogue as a way to restructure communities and to suggest possible assessment strategies for sustainable inter-community dialogue.

2 Theorising difference

2.1 A Local world or the global village

Anthony Mcgrew (1992) defines globalisation as the multiplicity of linkages and interconnections that transcend the nation states (and by implication the societies) which make up the modern world system. As a process, globalisation has lead to the crumbling of territorial boundaries; the shrinking of the world into a global village and is closely associated with the intensification of the time-space compression in social life.

Globalisation as we now understand it can be explored as a purely modern movement which began in the 20th century or it can be understood as the latest manifestation of a more established phenomenon which perhaps began with Columbus' expedition to the Americas in the 1400s (McCloskey, 2003). A more historical manifestation of globalisation may also be seen in medieval Islamic civilization, when at its zenith it included within its realm Spanish Andalusia, the Indian Subcontinent, Arabia and Western China. Trade, over-lapping cultures, migration and movements of peoples existed then but at a pace much slower than the accelerated processes and systems of modern globalisation.

Globalisation today is characterised by new innovations in technology and specifically, telecommunications; trade is driven by large financial and industrial corporations; and the movement of wealth is from the bottom to the top. The ramifications of globalisation stretch far beyond the corporate boardrooms that perpetuate it. It transcends beyond economic domains and constitutes a process which is manifested through unlimited technological and cultural change (McCann, 2003). It has increased interdependence between states, enhanced cultural awareness and developed more meaningful opportunities for cultural exchange (McCloskey, 2003). Globalisation can be a universalising force of progress, social improvement and international justice. (Hainsworth, 2003), but simultaneously social polarisations of wealth and increased inequalities inevitably accompany it.

As a consequence, of the investment and trade driven global economic order, societies and their economics are induced to reframe and constantly renew their societies in order to keep apace with the ever-changing economic order. Migration and immigration leads to new dominant cultures which compete with and, in some cases, are replacing traditional values and traditions. The emerging structures that are manifesting themselves are like the empires of the past – transcending political borders, reducing fiscal constraints, promoting a monolithic cultural identity and developing at an unimaginable speed. As places and peoples are bought together, so are their cultures, values and identities leading to a new interpretation of human society, and identity which crosses traditional spatial, cultural and political boundaries (McCann, 2003).

2.2 Globalised-hybrid identities

Traditional fixed national or cultural identities are very quickly lost in this confluence of cultures. Stuart Hall describes identification as an iterative process of evolution; change; adaptation; and transfer. Far from being all-inclusive, the resultant identity is in constant negotiation with the history, language, culture/s, class, society and caste of the individual (1992). Identity arises from the narrativisation of the self within dynamic external representations - the discursive construction of a 'we', of which the 'I' becomes a loyal and, perhaps, a contributing part irrespective of any differences or divisions (Hall, 1996) Identity is a reflection of the social on the individual and is created at the intersection of the public and private lives. As societal boundaries become more permeable and flexible, this is reflected onto the identities of individuals living in those societies. The identity of nation states for example are created out of, and continuously strengthened by, a common national history, which is read and understood by the individual in a common national language and which is reinforced through common symbols, celebrations and commemorative dates (Halbwachs, 1941; Poole, 2008; Anderson, 2006). But if the common national language is replaced by the dominant world language of globalisation; and the common history is no longer that of the nation but that of the world, then national identity should become replaceable by a more inclusive, fluid and flexible world identity that reflects the layered loyalties of individuals.

Individuals and communities interact with sometimes conflicting stimuli from societies and cultures that are alien from their own. Fixed, centred national or cultural identities no longer exist but are merely imagined communities (Hall, 1992; Anderson, 2006) within which individuals are in a state of constant negotiation with cultures, nationalities, religions and races different from their own. The myriad of different value-systems and opinions that nations today encompass, leads to an amplification of the significance of identity positions (Tomlinson, 2003) that may at times be divergent or in conflict with each other. A young migrant to the United Kingdom, interviewed by this researcher for another research commented, when asked about her identity had this to say. She is a young French woman of Moroccan origin, who migrated to the UK, and is married to a British Pakistani.

> "When I go to Morocco, they say you are a stranger. When I go to France they say you are stranger. When I go to Morocco, I say I am Moroccan and they say "No you are not Moroccan you are French" When I go to France they say you are not French you are Arab because they don't make out the difference. And when I come to Britain I am confused sometimes and people tell me "Oh so where are you from". If I say I am French. They look at your face you are not French. And if I say I am Moroccan that doesn't work either. And I don't think that I have just come

> from Morocco and I don't feel Moroccan.... What are my children going to say – they are Moroccan, French, British, Pakistani. Its going to be confusing."

Globalisation induced movement of peoples, has added to the multiple facets of identity formation. Individuals migrate for financial reasons, from poorer to richer societies, or for socio-political reasons, but carry with them cultural baggage from their 'homeland' which merges into the culture and traditions of the host country. Very rarely is this a seamless merger of two cultures. Invariably tensions associated with antagonistic cultural practices; domination of one culture over the other; conflicting interests and agendas; or just plain difference surface, gradually upsetting the processes of integration into the host society. The relationship within plural societies is further compounded by the changing balances of power, between the perceived native community, and migrant communities, leading to justifiable suspicion from the native cultures. Subsequent demands for assimilation are justifiably met with suspicion, this time from the migrant culture/s. As communities share the same urban space and often have to compete for the facilities it offers, suspicions on both sides turn into insecurities and fears.

Is seamless assimilation a sustainable answer or would it simply fuel undercurrents of dissatisfaction and mistrust which will ultimately explode or perhaps implode within the community? Or rather is there a need to encourage the development of formal frameworks within which stakeholders in communities may engage in dialogue to arrive at sustainable answers to resolve these disparities. Answers must take into account the fact that heterogeneity rather than homogeneity is increasingly characterising the communities we live in.

> "Heterogeneity, discontinuity, displacement, destabilization - these terms may be items of post-modern academic accessorizing, but they also point to real elements of contemporary experience." Something is happening!"; an array of cultural alterations have significantly changed the conditions of life, changes which need to be named, described, and understood."(Bordo, 92)

Globalisation has bought about increased interconnectedness between the developing and the developed world. The financial gain driven capitalistic development has also been universal in increasing the inequalities within society. As the rich are becoming richer and the poor are becoming poorer, the inequalities are not limited to those across nations, but are within nations and also alarmingly within peoples (Greig et al, 2007). And as social inequalities increase, the tensions between communities become terser.

3Dealing with difference

The ramifications of these theoretical arguments are reified through various inter and intra community disputes. The rhetoric surrounding immigration in the UK - 'British jobs for British workers; the 'sons of the soil' versus the migrant labour unrest in Mumbai; inter-religious tensions and perhaps even violent extremism can be understood, as the result of economic inequalities; cultural differences; and uneven power relations – all an effect of the movement of peoples. This paper will explore how migration has affected socio-political dynamics in two multicultural and secular societies,

- In the context of urban Britain this paper will explore current and historic discourses in the public domain and in the academia, surrounding the volatility of identity and the mixed loyalties of individuals within the UK.
- Bombay the financial capital of India – a city with a history of diversity and tolerance. During February to October 2008 there were a series of clashes between 'native' and 'migrant' populations from the northern, less prosperous states. Identity politics shaped public opinions and gradually led to a breakdown in law

> and order. This paper will explore these events as they developed through news reports.

Global trends 2025 predicts while immigration to US may slow down, western Europe will continue to attract immigrants as will southern India and China. These societies hence offer a context to understand the inherent realities embedded in the current understandings of culture, identity and ideology, and present an opportunity to explore possible avenues to sustainable constructs of community.

3.1"What does it mean to be British?"

This entire globalisation discourse immediately becomes very pertinent in a multicultural, multi-lingual and multi-ethnic Britain wherein settled contours of national identity are constantly being challenged and reframed (Hall, 1992). The initial waves of migration into Britain can be traced back to 1945, till around 1962 when 1.1 million people of West Indian origin made the journey to Britain 'the mother country' to meet largely unskilled labour needs. The late 1950s brought migrant workers from the Indian subcontinent into the UK, which lasted till 1973. And 1974 saw the sizeable influx of Ugandan Asians who were fleeing the oppression of Idi Amin. Most analysts estimate this initial wave of migrant population to be around 3.5 million (Cross & Waldinger, 1992). Immigration into the UK hasn't stopped since, with an estimated 577,000 people arrived to live in the UK for at least a year in 2007, and 591,000 in 2006[1]. Britain today is a mosaic of different cultures, races, ethnicities, religions, values, attitudes and standpoints. It is within this multiplicity that the understandings of British-ness seem to be undergoing fundamental changes.

> Older certainties and hierarchies of British identity have been called into question in a world of dissolving boundaries and disrupted continuities. In a country that it is now a container of African and Asian cultures, the sense of what it is to be British can never again have the old confidence and surety. (K Robins cited in Hall, 1992 page 627).

It is not possible to define what it means to be British in terms of overarching physical and tangible commonalities rather British-ness seems to consist of unifying ideologies and values, but isn't this a little vague?. Varun Uberoi (2007) feels that only national identity can foster social unity and loyalty, and he theorises about the possibility of a 'British Multicultural National Identity' which could perhaps define British-ness through a 'multi-culturally constituted common culture' which can unite all the different players in the diverse national polity. In the book "The End of multiculturalism" Derek Mcghee (2008) posits that the British relationship with multiculturalism has almost taken an 'assimilationist' turn which rather than accepting inherent and enriching diversities, focuses instead on identifying 'norms of acceptability and compulsory values surrounding the responsibilities of citizenship'. He cites Alexander's (2007) reference to the 2001 Runnymede trust commissioned report which envisaged the future of multi-ethnic Britain. She says,

> *"Six years on, the ground has shifted subtly. But decidedly in political and policy terms away from this pluralist vision of Britain as a multicultural mosaic, and in favour of a reinvigorated and assimilative national project"*

The assimilative tendencies of current nationalist discourse will inevitably continue to fuel the suspicions of minority communities pushing them further away from a commonly constructed national culture and identity. It is important to distinguish assimilation from integration which can be defined as being inclusive and as embracing diversity as an

---

[1] Data retrieved from http://www.statistics.gov.uk/CCI/nugget.asp?id=260 on 14th Dec 2008.

integral part of the whole. Assimilation on the other hand is exclusive, seeking to further a dominant culture within which minority cultures must be seamlessly assimilated.

It was immigration that perhaps began this debate about national identity and culture, when on 20th April 1968, Enoch Powell referred to immigration as a preventable evil. He spoke of indigenous communities having to move away as migrant communities and their descendants took over entire localities and areas. As Leicester prepares itself to be the first city where whites will be a minority in 2025[2] this, understandably, can be a cause for concern within majority communities. Lord Carey (2008) the ex-Archbishop of Canterbury writes about the renewed media and the popular press fears of "sleepwalking into segregation"; "no-go areas" and more recently of "a kind of cold war in some parts of the country". He says that it is important for the church, for the government and British society as a whole, to address the '*deep visceral distress, bordering on anger, among many British people of all colours concerning migration*'. In what is perhaps a reflection of this status quo, two-thirds of Britons fear race violence, while 60% felt there were too many immigrants in Britain, and 52% felt that there was a 'fair amount of tension' between different races / nationalities[3].

The tensions associated with movement of peoples are an unavoidable reality of globalised urban life. In urban Britain immigration is often blames for the gradual erosion of British culture and values. In India migration with the political borders of the country has initiated similar tensions which will be explored in the next sub-section.

3.2The *Bihari* in Bombay - foreign in your own country?

This section will contextualise and then explore migration within India and specifically to Bombay. Before gaining independence in 1947, India consisted of innumerable princely states who spoke different languages, practiced different religions and who had their own cultures and governments. Independence from the British in 1947, united all these states into one democratic nation. Similar geographical integration in India historically existed during the Mughal era and before that during the reign of the Mauryas, but with different geographical borders and social systems. Modern India though a fully-integrated nation state has a history which is relatively new and primarily etched in the freedom struggle against the 'foreign' British. Yet a common collective 'Indian' identity has academically, politically and socially simulated a history that stretches far beyond its 61 years of independence. Thus 'Indian-ness' encompasses the historical, ethnic, lingual, cultural and religious multiplicity amongst its people, but this multiplicity also continues to be expressed in inter-regional and intra-regional politics.

Bombay, the capital of the state of Maharashtra, is the financial and cultural hub of the India and the world's fifth most populous city. It origins are in a group of 7 islands, which were leased to the British East India Company in 1668 for a sum of £10 per annum. Bombay with its strategic location on the western coast of India very quickly became one of the largest and busiest ports in the Arabian Sea. The opening of the Suez Canal in 1869 transformed Bombay, making it a commercial hub for the South Asian region. As it developed, it became well-known for education, arts, trade and culture; its prosperity attracted and continues to attract migrants from all over India. The migrants to Bombay come from very different economic and cultural backgrounds - qualified professionals to unskilled labour - all lured by Bombay's proverbial 'streets lined with gold'.

Described as a mega-polis, this is a city of extreme inequalities; that have been compounded by India's growing economy. Bombay offers a a near perfect opportunity to

---

2 http://www.independent.co.uk/news/uk/this-britain/leicester-to-be-first-city-where-white-people-are-minority-401968.html

3 http://news.bbc.co.uk/1/hi/uk/7352125.stm retrieved 17th april 2008

study the effects of migration – as populations grow, so too do demands on the the city's infrastructure. Accommodation is scarce and where available is often beyond the financial capabilities of the ordinary 'Bombayite'; jobs are fiercely competed for; and the public transport system is extremely over-burdened. Often expensive residential and commercial properties in Mumbai are built besides slums where people live in squalor and without ample access to basic hygiene amenities or clean drinking water. It will be useful to see how these inequalities are manifested in migration and identity discourses in Bombay.

The name of the city 'Bombay' or 'Mumbai' and the process that initiated this change of name from the former to latter, can be understood as part of the debate between identity, ownership and diversity within this city. Maharastrians claim to be the 'original' inhabitants of Bombay. However this statement is debatable as no single community, except perhaps the local fishing community, existed in Bombay before it evolved into a commercial hub . Maharashtrians are Indians citizens, but like Indians from other states, they have their own unique language and cultural identity. The Maharashtrians subscribe to their Maratha culture, with its unique history, landmarks and heroes - the most famous of Maratha icons is Shivaji - the founder of the 15th century Maratha State.

In 1996 after years of being in the opposition, the alliance between the Hindu right wing political party and its more extreme partner the Shiv Sena, came into power in the state and changed the name of the city from Bombay to Mumbai. The Shiv Sena leadership, despite claims of a nationalist agenda, continues to play regional politics and asserts to be the voice of the local Maharashtrian population. The name-change of the city was accompanied by name changes for many major landmarks in the city - the Victoria Terminus Train Station was changed to the Chatrapati Shivaji Terminus; the Mumbai zoo earlier known as Victoria Gardens is now known as the Jijamata Udyaan (Jijamata was the mother of Chatrapati Shivaji) and the Sahar International Airport became the Chatrapati Shivaji International Airport or the CSIA! Though this was a campaign that purported to remove the nomenclature used by the colonial Raj and revert back to local names, there have been undertones and in cases outright allegations that these names-changes furthered a Maratha agenda - most changed names apparently either drew upon 'Marathi' histories and heroes rather than 'Indian' histories and heroes.

The Shiv Sena has often questioned the presence and role of non-Marathas in Mumbai, who as per their leadership, encroach upon the opportunities and fortunes of the 'Marathi Manus' – the local Maratha 'son of the soil and in the 1960s and 1970s the Shiv Sena campaigned against South Indian migrants in Bombay. It alleges that excessive migration has led to the marginalisation of the Maharashtrian in his own land – a standpoint that is mirrored completely in anti-immigration discourse in the UK. In 2008 an offshoot of the Shiv Sena, the Maharashtra Navnirman Sena (MNS)[4] clashed with migrants from the north Indian state of Bihar. This paper will focus on this recent anti-Bihari campaign to explore the praxis and ramifications of identity politics.

Bihar is a state in northern India and is representative of what is also known as "the northern Hindi-speaking belt" of India formed by the states of Bihar, Uttar Pradesh, Uttarakhand and Jharkhand. These states are primarily agricultural economies, however droughts, floods and political corruption have left these states impoverished. Typically the younger generations choose to migrate in search of economic security. Often migrants are young able-bodied males who move to the city in search of hard labour, and who initially fitted in unobtrusively within various communities. Typically when a certain level of financial stability is achieved, families – wives, children and other male members - are invited to join the original migrant and 'share his prosperity'.

---

[4] he MNS – Maharashtra Navnirman Sena (literal translation Army for the rebuilding of Maharashtra) was established by the nephew of the current Shiv Sena head and founder after a family dispute on 9th of March 2006.

As the populations of Bombay grows, the strain on Urban resources combined with changes in the ethno-religious composition is perceived as an immediate effect of the economic migrant. This initiates conflicts, which are perpetuated by an underlying fear of the 'different other' encroaching on and taking over local resources and facilities. For the local Maratha 'son-of-soil' the Bihari's presence, is hence perceived as competition and a threat. To the migrant however, his 'move' and 'use of resources' is simply a birth right, and in the case of the Bihari, this is a right given to him by his Indian nationality. The theoretical conflict between natives and migrants became real, when in early 2008 clashes erupted between the MNS and the Bihari migrants. Newspaper articles will be used to reconstruct this anti-Bihari and anti-north activism in Bombay. All quotes are from on-line editions of The Hindu and The Times of India (TOI) - national broad-sheet dailies in India.

In early February, 2008 newspapers carried reports of violent clashes between the MNS and the Samajwadi Party (SP) – a political party with North Indian origins and affiliations. The MNS party spokesperson told the media, that the party was provoked to act in the way it did. He also added, "*When in Maharashtra, they must act like Maharashtrians. They [referring to North Indians] must adopt our way like saying Mumbai and not Bambai*"(The Hindu, 4th Feb 2008). This can be interpreted as a classic demand for assimilation into the dominant culture being made by a segment of the native population.

Such reports of an anti-north Indian stance and assimilative demands intermittently appeared in newspapers and current affairs programmes through 2008. In August 2008 the natives decided to 'enforce' their assimilative demands. The MNS threatened all shops and commercial institutions in Mumbai with "dire consequences" if they did not put up mandatory name-boards in Marathi, the state language, by 28th August (The Hindu, 10th Aug 2008). It must be clarified, that displaying name-boards in Marathi was a legal requirement and that 28th August was a deadline set by the local Municipal Authorities. The MNS however took it upon itself to impose this law which it had no legal authority to do.

As various shopkeeper's associations litigated this in court, statements were made by shop-owners as well as the MNS. Shop-owners demanded the freedom to choose how they displayed their names. But the MNS remained adamant,and a spokesperson made this statemet "*Mumbai has given them the chance to do well. They should respect local aspirations. Our August 28 deadline stays*" (TOI, 26th Aug 2008). As the socio-political environment threatened to become hostile, the legal system clicked into action and the High Court restrained the MNS leadership and members from indulging in any violence or defacement of property of shop owners who failed to comply with the deadline(The Hindu, 29th Aug 2008). The police was ordered to take preventive measures; law and order was maintained; and the Muncipal authorities later took legal action against the shops that failed to comply with the deadline (TOI, 4th Sep 2008).

In October 2008, identity politics flared up again and this time law and order situation was extremely compromised. The MNS attacked north Indian applicants for jobs with the Indian Railways, when they arrived in Mumbai for a recruitment examination (The Hindu, 20th Oct 2008). The subsequent arrest of MNS leader, Raj Thackeray, by Mumbai authorities caused further chaos, uproar and rioting, leading to the death of three people. In Bihar the result of all this mayhem in Maharashtra led to anti-MNS protesters going on rampage in Bihar - burning trains, vandalising railways stations, disrupting rail and road traffic (The Hindu 23rd Oct 2008). On 24th October 2008, the chief minister of Bihar wrote to the Indian Prime Minister urging him to intervene so that law is enforced in Maharashtra and "... people are free to move around, to pursue their studies, their vocations, their trades and tours. He also wrote about the perpetuators of anti-Bihari crimes that "precious little was done to apprehend such elements and punish them which would have acted as deterrents for the future". And said that the violent protests in Bihar were a direct consequence of events in Maharashtra (TOI, 24th Oct 2008).

Many Maharashtrians disassociate themselves from the MNS' brand of politics, however the implications of such identity politics are only too real for the residents of Bombay. The MNS-Bihari episode may be an extreme example of identity politics spiralling out of control, however with diversity in urban environments only set to increase, this becomes a very real threat to the sustainability of urban communities. As the war of words, actions and identities between the native and the migrants in Bombay continue, the urgency with which urban communities must discuss their differences becomes evident. And is something that Urban planners must account for in their policies and plans.

4 (Re)Defining 'community' through sustainable dialogue

These discourses and events surrounding current (non)interpretations of "British-ness" or identity politics in India, indicate a definite need to contextualise the reasons and effects of movement of peoples on urban communities. There is a need for urban planners, strategists and thinkers to understand the immigration-led changes within communities and contextualise them into our current readings of culture and identity. Communities need to be actively encouraged to discuss their differences and develop shared community values which can form the basis of a shared culture. Inter-community dialogue is one way in which this may be achieved and which has a precedent in inter-religious dialogue. It is imperative for the future of communities that barriers within them be broken down through active engagement with difference.

Siddiqui (1997) describes the essence of dialogue as communicating one's stand in an assembly.....in a sympathetic way to others..... and also listening to others.....based on mutual respect (and) to operate in areas of packed social and other spheres whereby our common values can be exercised and utilised. Though he presents this definition in the context of inter-religious dialogue, which has its own, sets of assumptions, this is a generalised interpretation that can be easily related to the dilemma superimposed by globalisation on identity. As barriers of (in)difference are replaced by attempts to engage with the 'different other', the reasons of individual are revealed to the community that he or she lives in.

There are various more tangible interventions that may accompany such dialogue. For a sustainable urban community, the sensitivities of various cultural stake-holders must be contextualised into governing mechanisms and policies of a community. The varying needs of diverse parts of a society must be recognised, understood and provided for. Better understanding would pave the path for efficient civic planning that would account for the needs of the entire community, while simultaneously reducing prevalent inequalities. Local business must be encouraged, the contributions of cultures must be celebrated and public spaces must be shared.

Like with most sustainable initiatives it is difficult to set the criteria for the assessment of such interventions. The extreme volatility and sensitivities of inter-community dialogue adds to the complexity of this task. However inter-religious dialogue has set a few precedents which can be adapted to more broad-based dialogue. With the usual caveats about unpredictability; inadequacy of knowledge; diversity in contexts and unrecognised possibilities of conflict (Gibson et al; 2005) the following could be an initial framework for sustainable dialogue. And a beginning could be made in the World Cultural Report definition of culture as, 'The ways of living as individuals and ways of living together (Choe et al, 2007)'. Therefore for dialogue to be sustainable it must;

1. aim at genuinely understanding, accepting and giving equity to difference within communties.
2. must be driven officially as well as through informal public initiative.
3. represent ongoing engagement between two or more individuals, cultures or societies
4. include those practices which are likely to be preserved and enhance the life experiences of future generations.
5. contextualise the spaces that individuals inhabit and therefore describe as their own.
6. contextualise the cultures and identities of individuals that overlap and understand the symbiosis between them.
7. result in pragmatic tangible recommendations – which have a voice in government processes, policies and interventions.
8. identify areas of potential conflict
9. suggest ways and means to not necessarily solve but to deal with conflict.
10. like other sustainable action it must plan, design and account for unexpected eventualities which it should be adaptable to (Gibson et al; 2005).
11. attempt to meet all the requirements for sustainability together as a set of interdependent parts, seeking mutually supportive benefits (Gibson et al; 2005)

5 Conclusion - dialogue as an aspect of sustainable communities

So does this research take an ambiguous stance on nationality, immigration and identity formation? Perhaps it does. It acknowledges that in many cities growing populations and increasing demands on resources may be a result of unchecked migration into these cities. However this research also acknowledges the economical and social contributions of migrants to host cities. Interestingly the Global Trends 2025 report states that “the annual level of immigration would have to double or triple to keep working-age populations from shrinking in Western Europe” (page 21).

This research has attempted to reiterate the fact that the cultural hegemony of a single culture is no longer a viable foundation on which to create a national identity or a common culture. Globalisation may have bought communities and nations unprecedently closer to each other, initiating presumptions of a dominant global culture that can supersede indigenous local cultures. But the irony of modernity is that by bringing communities closer on one level, it drives them apart on another, deeper level. As superficial assimilations mature, deeper antagonisms seem to embed themselves into common cultural psyche. The debate around British-ness is indicative of the sensitivities that can be aroused in a debate of this sort. The events in Bombay indicate that these events can result in serious disruptions of law and order. Within multicultural nations (and within peoples) all over the world similar expressions of identity politics and activism demanding more rights for the ‘sons of the soil’ seems to be gaining momentum which include.

- the British National Party's (BNP) stand against immigration in the UK
- Bhoomiputra politics in Malaysia
- and race riots in France

It is important for societies and communities to accept movement, difference and multi-layered identities as a predominant construct of the future. As urban populations continue to experience unprecedented growth, it is imperative that policy makers and social thinkers begin to think about managing diversity as a critical and real aspect of sustainable cities for the future. It is through sustainable dialogue, within and between, communities that barriers of suspicion and mistrust can perhaps be restructured as tools, to abet the processes of constructing shared identities; discovering commonalities; and celebrating inherent and increasingly unavoidable diversities within modern urban societies.

Concepts of moveable identity and otherness ratify research on various minority (and majority) communities, which form part of any imagined national identity, but also keep reasserting the need for greater understanding and dialogue between communities. Difference that is understood ceases to be unidentifiable, and hence need not be looked at with suspicion. This is perhaps the route to a sustainable approach that refuses to marginalise any particular group – it fulfils the need to promote community cohesion based on greater knowledge of, contact between and respect for various cultures that make up national identity. (Home Office, 2001). In such a state of flux, "otherness" and cultural diversity become relevant to any discourse on policy-formulation or good governance, and dialogue becomes a frame-work upon which to build a shared and sustainable future.

6 Acknowledgements

I would like to thank Graham Strachan for introducing me to sustainability discourses. I would also like to thank Murtuza Ali, my husband for giving me inspiration and support.

7 References

Anderson, B (2006). Imagined Communities. London: Verso

Bell, S & Morse, S (2003). Measuring Sustainability – Learning from Doing. London: Earthscan

Booth, J (2008). 'The Work of Memory: Time, Identity and Justice'. In Social Research Spring 2008, Vol. 75, Issue No. 1, pp.237 – 262

Bordo, S (1992). Find More Like this Postmodern Subjects, Postmodern Bodies. in Feminist Studies; Spring92, Vol. 18 Issue 1.

Choe, S, Marcotullio, P and Piracha, A in 'Approaches to Cultural Indicators' in Nadarajah, M and Yamamoto, Ann (Eds) (2007) Urban Crisis – Culture and the Sustainability of Cities. New York: United Nations Press

Cross, M and Waldinger, R (1992) 'Migrants, minorities, and the ethnic division of labor' in Fainstein, S, Gordon, I & Harloe, M (Eds) (1992) Divided Cities – New York & London in the Contemporary World. Cambridge: Polity Press

Edgerton, G (2003). 'Introduction: Television as Historian: A different Kind of History Altogether'. In Edgerton, G & Rollins, P (2003) Television histories: shaping collective memory in the media age. Kentucky: University Press of Kentucky. pp 1 - 9

Frisby, D (2001) Cityscapes of Modernity. Cambridge: Polity Press

Gibson, R; Hassan, S; Holtz, S; Tansey; J and Whitelaw, G (2005). Sustainability Assessmet – Criteria and Processes. London:Earthscan

Global Trends 2025: A Transformed world. Retrieved on 10 December 2008 from http://www.dni.gov/nic/NIC_2025_project.html

Greig, A; Hulme, D; & Turner, M (2007). Challenging Global Inequality – Development Theory and Practice in the 21st Century. New York : Palgrave Macmillan.

Hainsworth P (2003). 'Towards the Globalisation of Justice: An international Criminal Court' in McCann, G & McCloskey, S (Eds) (2003) From the Local to the Global – Key Issues in Development Studies. Sidmouth: Pluto press.

Halbwachs, M (1941) On Collective Memory. Edited, Translated and Introduced by Coser, Lewis (1992) London: University of Chicago Press

Hall, S (1992).'The Question of Cultural Identity' in Hall, Stuart, Held, David and McGrew, Tony (eds) Modernity and its Futures. Cambridge: Polity Press. pp. 273 – 326.

Hall, S (1996). 'Who needs 'Identity'?' in Hall, Stuart and du Gay, Paul (eds) Questions of Cultural Identity. London: Sage Publications, pp. 1 - 19.

HM Government (2005) Sustainable Communities: People, Places and Prosperity

Jenkins, R (2004). Social Identity 2nd Edition. London: Routledge

McCann, G (2003) Globalisation and Development: Charting the future in McCann, Gerard & McCloskey, Stephen (Eds) (2003) From the Local to the Global – Key Issues in Development Studies. Sidmouth: Pluto press.

McCloskey, S (2003). 'Introduction: Whither development in the Age of Globalisation' in McCann, G & McCloskey, S (Eds) (2003) From the Local to the Global – Key Issues in Development Studies. Sidmouth: Pluto press

McGhee, D (2008) The End of Multiculturalism – Terrorism, Integration and Human Rights. Berkshire: Open University Press

McGrew, A (1992). A Global Society in Hall, Stuart, Held, David and Mcgrew, Tony (eds) Modernity and its Futures. Cambridge: Polity Press.

Mean, M & Tims, C (2005). People Make Places: Growing the Public Life of Cities. Poole: Lookers

Nadarajah, M and Yamamoto, A (2007) 'Introduction' in Nadarajah, M and Yamamoto, A (Eds) (2007) Urban Crisis – Culture and the Sustainability of Cities. New York: United Nations Press

Poole, R (2008). Memory, Responsibility, and Identity. in Social Research; Spring 2008, Vol. 75 Issue 1, pp. 263-286.

Siddiqui, A (1997). Chritian-Muslim Dialogue in the Twentieth Century. London: Macmillan

Taylor, E (1958). The Origins of Culture. New York: Harper and Row

Tomlinson, J (2003). Globalization and Cultural Identity. Retrieved June 27th, 2007 www.polity.co.uk/global/pdf/GTReader2eTomlinson.pdf

Uberoi, V (2007) 'Social Unity in Britain' in Journal of Ethnic and Migration Studies Vol. 33, No. 1, January 2007, pp. 141 to157

Evaluation of strategic water river management through analytical network process: a case study

Prof. Patrizia Lombardi

Politecnico di Torino, Italy

In strategic planning and management of environmental resources, multicriteria analysis is often used for evaluating alternative development scenarios against a set of decisional criteria. However, the modeling of the decision making problem is usually based on a hierarchical structure which is inadequate to represent the complexity of the issues involved in a decision. In particular, water management and strategic planning usually deal with both 'traditional' issues such biodiversity, flora and fauna, population, health, water, soil, landscape and other aspects related to mobility, energy efficiency, climatic change which are more closely linked to human activities and their impacts on the eco-system. These issues, as mentioned by the EU Directive on SEA (2000/60/CE), are often interrelated and dependencies can be recognized among the aspects involved.

The aim of this paper is to discuss methodological aspects of managing conflicting interests concerning the use of territorial resources and to improve the integration of the strategic evaluation in the decision making process within the management of territorial development policies.

In particular, the paper suggests the application of the Analytic Network Process (ANP), an advanced version of the Analytic Hierarchy Process (Saaty, 2006). The ANP is the first mathematical theory that makes possible to systematically deal with all kinds of dependencies and feedback among decision elements. It requires the identification of a network of clusters and nodes, as well as pair-wise comparison to establish relations within the elements. An application of the method is illustrated related to the Strategic Management and Planning of River Po, in Italy.

The paper is structured in four main sections. The first one discusses the problems related to the strategic evaluation of water resources according to the SEA, highlighting the need for more appropriate evaluation methodologies; section two and three present, respectively, the case study and the ANP application of the method; finally, section four discusses the results and the next steps.

Keywords: Analytic Network Process, strategic environmental assessment, water management

1 Introduction

Strategic planning and management of environmental resources is a complex activity which usually requires the application of multi-criteria analysis (MCA) for evaluating alternative development scenarios against a set of decisional criteria. In particular, planning and management of water usually deals with multiple and conflicting issues which are concerned with territorial, economic, environmental, social components. The list of issues mentioned by the EU Directive on Strategic Environmental Assessment, SEA (2000/60/CE) includes, alongside 'traditional' issues such biodiversity, flora and fauna, population, health, water, soil, landscape, aspects related to mobility, energy efficiency, climatic change which are more closely linked to human activities and their impacts on the eco-system. These issues are often interrelated and dependencies can be recognized among the aspects involved.

In particular, in water district planning and management, the selection of environmental objectives is influenced by the complex reciprocal interactions between the water district conditions and the human (social, economic and cultural) activities. Unfortunately, traditional multicriteria decision-aid techniques are generally based on linear or hierarchical analytical schemes which are usually inadequate to represent the complexity which characterized the decision in water district planning and management.

The paper suggests the application of the Analytic Network Process (ANP), an advanced version of the Analytic Hierarchy Process (Saaty, 2006). The ANP is the first mathematical theory that makes possible to systematically deal with all kinds of dependencies and feedback among decision elements. This model seems more appropriate for representing and supporting decision making in this area because it provides an identification of all the clusters of elements involved in the decision. In addition, it allows pair-wise comparison between the aspects. This method has been successful applied to a real case study: the Strategic Management and Planning of River Po, in Italy

The paper is structured as follows. Section two discusses the problems related to the strategic evaluation of water resources according to the SEA, highlighting the need for more appropriate evaluation methodologies; sections three and four present, respectively, the case study and the ANP application of the method; finally, section five discusses the results and the next steps.

2 Strategic environmental assessment of water management: setting the problem

Council Directive 2001/42/EC requires that a preliminary environmental assessment be carried out in order to ensure that environmental issues are taken into consideration at the early stages of discussing and preparing plans and programs, and to guarantee that the changes in an area are correlated with the achievement of an acceptable level of sustainability. Specifically, the Directive states that environmental assessment must be integrated into the preparation of plans and programs, before their adoption or submission to the legislative procedure.

The introduction of the Directive, preceded in Italy by Legislative Decree 152/99, which foreshadowed some of its basic concepts, completed the regulatory framework governing the use and protection of water resources, making several substantial changes.

In addition to safeguarding aquatic ecosystems and wetlands depending directly on them and promoting sustainable use of water resources (and hence reducing water pollution), the general goals set out by the Directive include protecting water resources and mitigating the effects of extreme events such as floods and droughts.

The specific environmental objectives indicated by the Directive differ according to the water system and its context. Thus, the Directive identifies three types of system: surface water, ground water and protected areas. Management programs and initiatives for protecting water resources focus on individual river basins or on river basin districts in cases where the intent of the Directive can be more effectively served by considering the higher-level water system.

The main tool contemplated by the Directive is the River Basin Management Plan (RBMP), which "plans and schedules the action and requirements for the conservation and stewardship of the soil and the correct use of water resources on the basis of the physical and environmental characteristics of the geographical area concerned." (Law 183/89, Article 17, paragraph 1). Its specific content and aims are specified in Law 183/89, and reflect the range and complexity of the issues to be dealt with, as well as the plan's innovative scope. The river basin is seen as the basic ecosystem unit for all aspects of water governance. Responsibility for drawing up the plan lies with the River Basin Authority.

The Community Directive states that environmental assessment must be integrated into the preparation of plans and programs, before their adoption or submission to the legislative procedure.

As part of a planning process of this kind, environmental assessment must in turn interact closely with the dynamics of the changes and the measures implemented in and for the areas concerned. This means that it must also be seen as an on-going process, keeping pace with the construction of environmental sustainability scenarios that are consistent with the economic and social conditions that prevail in these areas. Consequently, it must be capable of furthering the progress of the planning process.

As used in river basin planning, then, the SEA method is designed to adapt to the processes of change in the territorial and planning systems, and thus has the flexibility needed to support the process as it moves forward. In this sense, the SEA complies in full with the first four articles of the Directive, as specified in the WFD implementation document of 2003, and gains additional value when interpreted as an integration strategy which encourages political decision-makers to bear environmental considerations in mind when formulating a policy, plan or program.

In the context of the strategic environmental assessment of water district management, this study presents the application of an innovative approach, named ANP, for the evaluation of strategic environmental resources for the River Po District Management Plan. The aim is to prioritize the strategic actions included in the Management Plan by using a more coherent and consistent network representation of the decision elements. In the next sections the case study and ANP application are described.

3 The River Po District Plan case study

The Po river basin extends through Liguria, Piedmont, Valle d'Aosta, Lombardy, Trentino, Veneto, Emilia-Romagna and Tuscany, and also penetrates into parts of France and Switzerland (see Figure 1). Consequently, there are municipalities whose territory lies entirely in the Po basin and, along the basin's edges, municipalities with a certain proportion of territory lying within it.

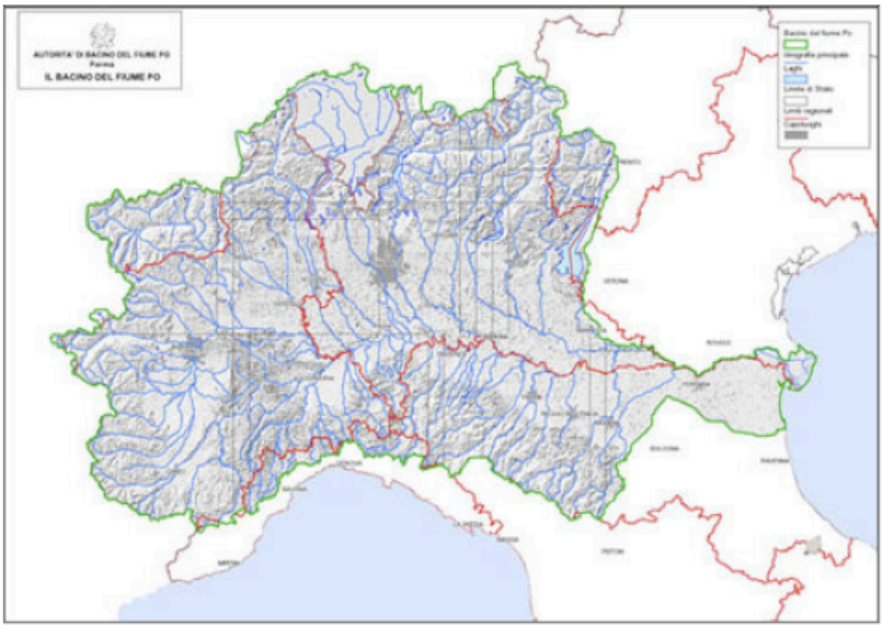


Figure 1: The River Po District

For several years, the Po River Basin Authority has been working to achieve safer conditions for the Po valley's inhabitants, protect the riparian corridors, improve the ecological network and preserve the quality and quantity of water resources, while at the same time promoting river tourism and public access to environmental, historical and cultural resources. All of the objectives set by the River Basin Authority are outlined in the Po River Valley Special Strategic Project, or SSP (Autorità di Bacino del fiume Po, 2008), in which the Authority has attempted to institute an integrated policy of action for protecting the soil, safeguarding water and environmental resources and valorising the area which goes beyond a disjointed, piecemeal approach to centre on the coordinated, synergistic use of the various available tools.

The Strategic Environmental Assessment process is one facet of the SSP development process, in which preliminary studies of its sustainability and compliance with strategies fielded by Community, national and regional policies have already been carried out. It is also part of the River Basin Authority's efforts to ensure that planning activities continue to reflect the latest European Directives. This Project, in fact, aims to establish methods and procedures capable of guaranteeing the effective implementation of Directive 2001/42/EC on the assessment of the effects of certain plans and programs on the environment.

The Project calls for four areas of action:

1. Watercourse restoration, increases in riparian corridor buffer capacity and flood bed reshaping
2. Conserving the ecological integrity of the riparian corridor and the Po's water resources
3. System of utilization and of cultural and recreational offerings
4. System of governance and of intangible networks for understanding, education and participation.

The project is the first of its kind in Italy, as a strategic environmental assessment of the SSP will be conducted to ensure full compliance with sustainability criteria, including those embodied in the recent corrections and additions introduced by Legislative Decree 152/2006, the so-called Environmental Code. As part of a planning process of this kind, environmental assessment must in turn interact closely with the dynamics of the changes and the measures implemented in and for the areas concerned. This means that it must also be seen as an on-going process, keeping pace with the construction of environmental sustainability scenarios that are consistent with the economic and social conditions that prevail in these areas. Consequently, it must be capable of furthering the progress of the planning process. As used in river basin planning, then, the SEA method is designed to adapt to the processes of change in the territorial and planning systems, and thus has the flexibility needed to support the process as it moves forward.

4 The ANP methodology and application

Inside the large 'family" of MCA (Figueira et al., 2005), the Analytic Network Process (ANP) is the only decision support method which makes possible to deal systematically with all kinds of dependencies and feedback.

The ANP is a generalization of the Analytic Hierarchy Process (AHP), developed by Saaty (2001). The model consists of clusters, elements, interrelationship between clusters, and interrelationship between elements. It allows interactions and feedback within and between clusters and provides a process to derive ratio scales priorities from the elements (Saaty, 2005).

The ANP requires a network structure to represent the problem, as well as pair-wise comparison to establish relations within the structure. Table 1 synthetically describes the main differences between MCA, AHP and ANP.

There are two possible modelling approaches to ANP: the BOCR (Benefits, Costs, Opportunities, Risks) approach, suggested by Saaty (Saaty and Vargas, 2006), which allows to simplify the problem structuring by classifying issues into traditional categories of cost and benefit; and a free-modelling approach, which is not supported by any guide or pre-determined structure.

The latter is applied in the case study of Strategic assessment of water planning and management, following three main steps, as described in the next sub-paragraphs:

1. Modelling the decision making problem (problem structuring);

2. Development of comparative assessments;

3. Analysis of the results obtained.

Table 1: Synthetic description of the methods

MCA – Multicriteria Methods	These are tools that support comparison of e.g. different policy options on the basis of a set of criteria. The robustness of an MCA result depends on the (un)certainty of the information feeding into the selected criteria, on the priorities given to the criteria (the weights or importance) and the extent to which these weights are commonly agreed upon by stakeholders
AHP – Analytic Hierarchy Process	It is one of the best known and most widely used MCA approaches. It allows users to assess the relative weight of multiple criteria or multiple options against given criteria in an intuitive manner, using pairwise comparisons.
ANP – Analytic Network Process	It is a generalization of the AHP. The basic structures are networks. Priorities are established in the same way they are in the AHP using pair-wise comparisons and judgements.

4.1 Modelling the decision making problem (problem structuring)

The ANP evaluation was conducted by a focus group, composed by the supervisors of the River Basin Authority Pilot Project and the members of the work group in charge for the evaluation of the project, at the Po River Basin Authority in Parma on May 21, 2008.

The decision problem addressed by the group, which corresponded to the objective "The Po as a territorialized and integrated system", was broken down into a number of decision elements which were then grouped together into clusters (see Figure 2). The first cluster consisted of the elements to be evaluated, viz., the environmental categories (evaluation topics), which will be verified and ordered according to priority. The next three clusters consisted of the areas of action, broken down in turn into the individual actions, i.e., the nodes or elements in the cluster.

As its end result, this simulation establishes a ranking in terms of importance for all the elements making up the network, and the prioritized environmental categories in particular.

After identifying the nodes of the problem, the relationships of influence in the network were structured. This involved identifying the links between the various elements in the network, or in other words the relationships and the directions of influence between the decision elements. The relational model is shown schematically in Figure 2.

One of the first relationships of influence that can be identified is that exerted by the criteria belonging to the areas of action on the alternatives. As it was assumed that the alternatives are influenced by the elements making up the clusters, a red arrow goes from each "area of action" cluster towards the "environmental categories" cluster. It was also assumed that the environmental categories can influence the nodes of the three clusters; accordingly, a second red arrow was placed in the direction of each "area of action" cluster. In addition, links were found between nodes belonging to different clusters. In the diagram, these links are represented by green arrows. Finally, the third type of relationship consists of the links between nodes in the same cluster, which are designated by a blue arrow starting from the cluster and returning to it, which denotes the effect of feedback. The various links are shown in Table 2.

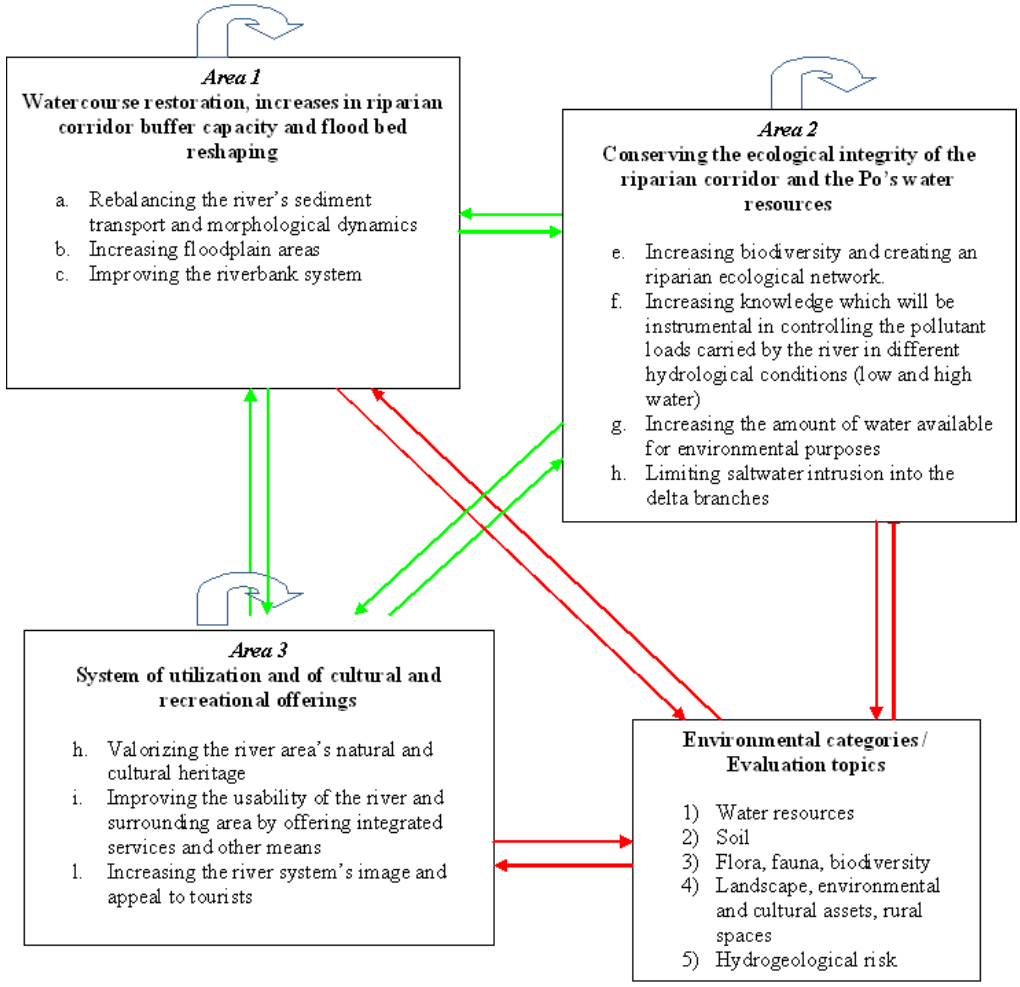


Figure 2: The ANP model.

Table 2: Interrelations between the nodes in the three areas of action

ACTIONS		AREA 1			AREA 2				AREA 3		
		a	b	c	d	e	f	g	h	i	l
AREA 1	a		X		X			X	X		X
	b	X		X	X			X	X		
	c		X								
AREA 2	d	X	X			X	X	X	X		X
	e				X			X		X	X
	f				X			X			
	g		X		X	X	X		X	X	X
AREA 3	h	X	X	X	X	X	X	X		X	X
	i								X		X
	l								X	X	

4.2 Development of comparative assessments

The application of a ANP requires pairwise comparison and relative weight estimation, as in the standard AHP. The determination of relative weights is based on the pairwise comparison (Saaty, 2000). These give to the decision makers a basis to reveal their preference by comparing two elements. Furthermore, the decision maker has the option of expressing preferences between the two as equally preferred, weakly preferred, strongly preferred, or absolutely preferred, which would be translated into pairwise weights of 1, 3, 5, 7 and 9, respectively, with 2, 4, 6 and 8 as intermediate values.

Pairwise comparisons of the elements at each level are conducted with respect to their relative importance towards control criterions or clusters. In this case study, each node of the clusters has been assessed with regard to the node placed at the top of the model. For instance, at the level of alternatives, it has been asked: "what environmental category is more important between water and soil with regard to the objective (a) of "rebalancing the river sediment's transport etc. and how much?".

The experts involved in this participative evaluation process had the possibilities to express their judgment, measured on a 9-point-scale, which has been then reported in pair comparison matrices. If expert opinions are different or conflicting, the method suggests to achieve a compromise though discussion and an intermediate pairwise weight can be selected in the 9-point scale.

This assessment process has been developed for all the elements in the clusters and, subsequently, a "supermatrix" of paired comparisons and its normalisation by cluster, has been developed in accordance to the ANP procedure (Saaty, 2000). The application has been developed using the specific software available on: http://www.superdecisions.com/.

4.3 Analysis of the results

The first result obtained is the ranking of criteria set, as illustrated in Figure 3. This figure shows that the most important criterion is belonging to the Area 3 on the system of utilization and of cultural and recreational offerings, named "valorising the river area's natural and cultural heritage" (h), with a weight equal to 0.551. Next important criteria are related to the Area 1 and the Area 2, focusing on protection, restoration and conservation, as follows: the node "increasing floodplain areas" (b), belonging to Area 1 (watercourse restoration, increases in riparian corridor buffer capacity and flood bed reshaping) with a weight equal to 0.475; the node "rebalancing the river's sediment transport and morphological dynamics" (a), belonging to the same Area 1 with a weight equal to 0.445, and the node "increasing the amount of water available for environmental purposes" (g), belonging to Area 2 (conserving the ecological integrity of the riparian corridor and the Po's water resources), with a weight equal to 0.434.

These results are not surprising and reflects the River Po Basin Authority attempt to institute an integrated and coordinated policy of action for both protecting and valorising the environmental resources.

The second result of this analysis is the final ranking of the alternative environmental categories. This is illustrated by Figure 4. The highest position is occupied by the landscape and cultural heritage (43%), followed by water (27%). The theme of flora and fauna and biodiversity is as much important as the hydrogeological risk (13%) while the soil (3%) is the last one in the list.

The higher priority assigned to the cultural heritage and landscape, compared with water and soil, clearly reflects the higher weight assigned to the criterion (h) on valorisation in Area 3 rather then conservation (Area 2).

5 Conclusive remarks

This paper has illustrated an application of the ANP to the SEA of the Italian River Po Basin Plan. This case study represents the first application of ANP to the strategic assessment of water management at international level.

This evaluation approach for the alternative environmental strategic objectives is innovative because it allows a better representation and fill assessment of the complex reciprocal interactions between the water district conditions and the human (social, economic and cultural) activities.

In water district planning and management, usually, the evaluation is conducted by adopting traditional impact assessment techniques which are based on bi-dimensional and hierarchical schemes. These does not tolerate an interrelated and holistic assessment of all the components, including those within the same cluster which may led to a change in the ranking.

This approach has improved the integration of the strategic evaluation in the decision making process within the management of territorial development policies, thanks to a better representation of the interrelations of the aspects in the network model.

For tackling a ANP application correctively, usually, it is necessary to deeply study the existing influences and the interrelations among nodes and clusters. This technique requires pair-wise comparison questions among elements. The number of questions is related to the number of interrelations. It is important to focus on the most important ones, in order to avoid the creation of a large number of questions which will be impossible to manage inside a focus group. This often represents a major limit of a ANP application.

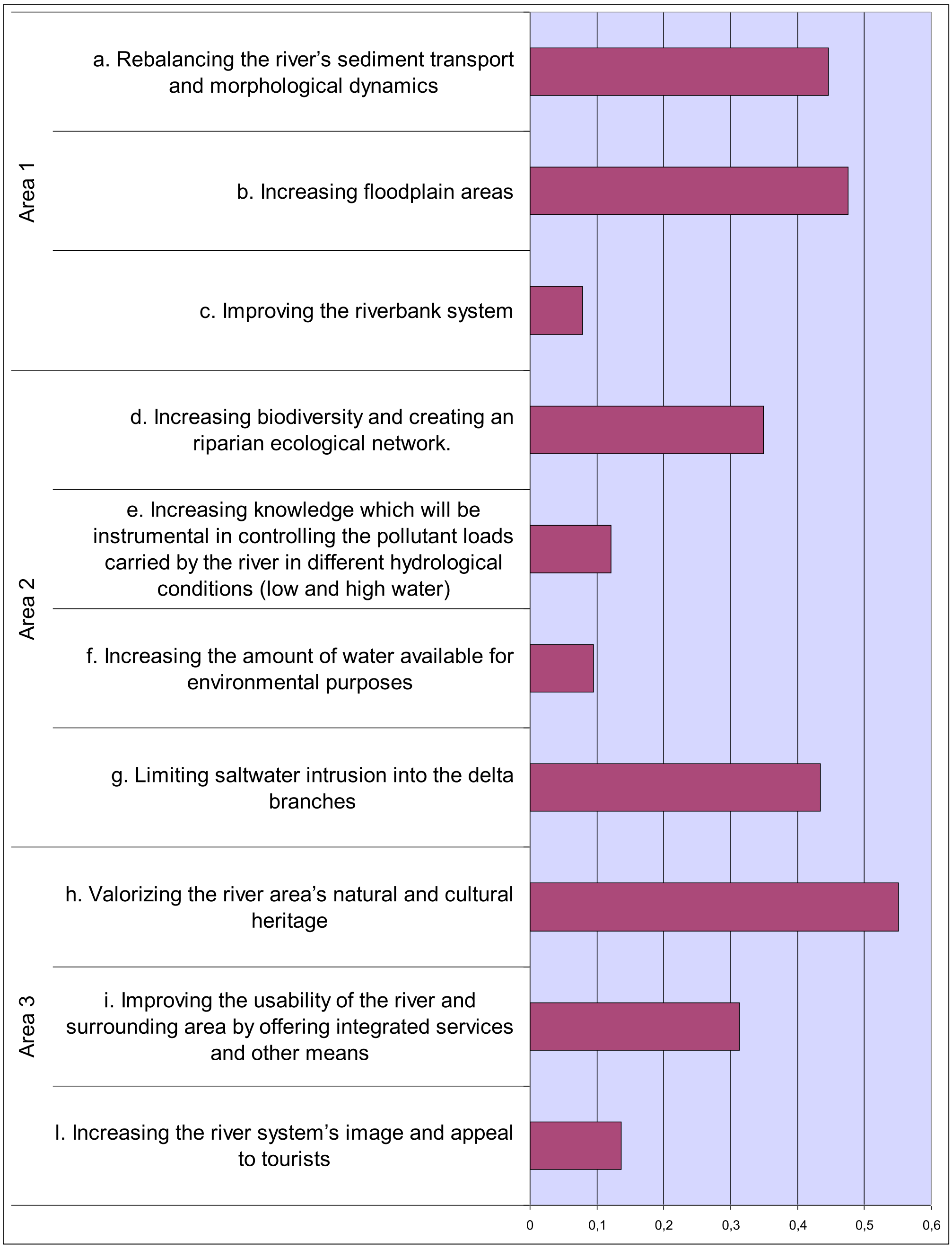


Figure 3: Weights of evaluation criteria

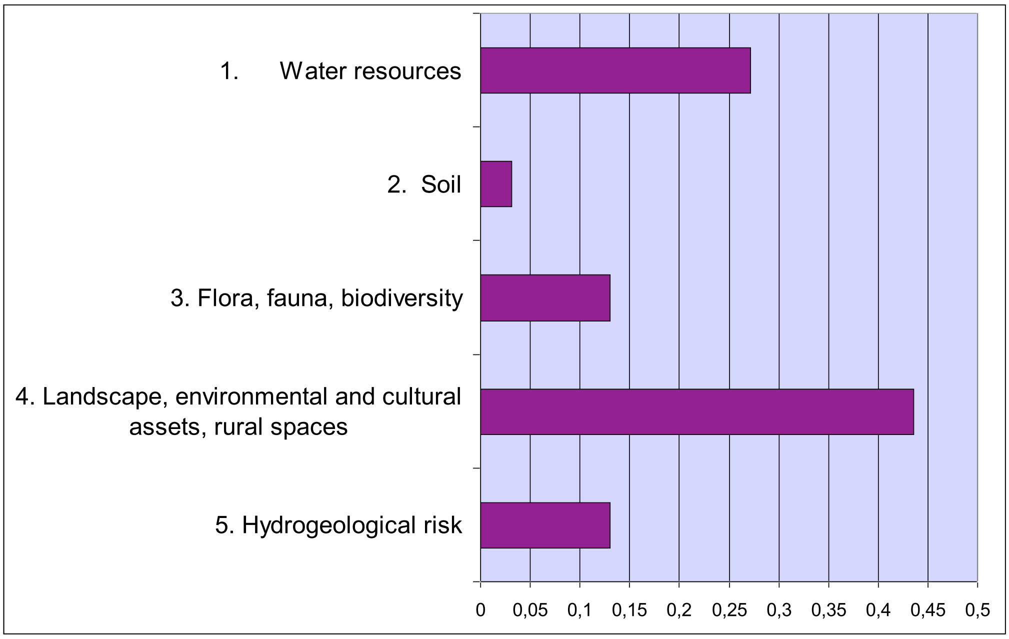


Figure 4: Final ranking of the environmental categories

Acknowledgements

This study has been developed by the author as member of the team participanting to the national project titled: "Progetto Pilota per l'applicazione della valutazione ambientale strategica alla pianificazione di bacino e alle fasi di recepimento nei piani territoriali (2007/08)", funded by the Basin River Po Interregional Authority, coordinated by prof. Attilia Peano of the Politecnico di Torino and managed by COREP (www.corep.it). The author wish to acknowledge the contribution of all the team of researchers and the civil servants of the River Po Authority. A special thanks to both Dr. Grazia Brunetta for her assistance in the planning and environmental assessment field and Alessandra Cicigoi for her technical support.

6 References

Autorità di Bacino del fiume Po (2008), "Progetto Strategico Speciale Valle del Fiume Po" – Rapporto Preliminare, May.

Bottero M., Lami I., Lombardi P., (2008), Analytic Network Process. La valutazione di scenari di trasformazione urbana e territoriale, Aracne, Firenze.

Brandon P., Lombardi P. (2005), Evaluation of Sustainable Development in the Built Environment, Blackwell, Oxford.

Bryson J. (1988), Strategic Planning for Public and Non profit Organizations, Jossey Bass, San Francisco.

Ciciotti E. and Perulli P. eds. (1998), La pianificazione strategica, Daest, Venezia.

Ciciotti E., Dall'Ara A., Politi M. (2001), "Valutazione delle politiche territoriali e governance dello sviluppo locale: aspetti teorici e di metodo", in Mazzola F. and Maggioni M.A. (eds.), Crescita regionale ed urbana nel mercato globale. Modelli, politiche, processi di valutazione, Angeli, Milano.

Curti F. and Gibelli M.C. (1996) (eds.), Pianificazione strategica e gestione dello sviluppo urbano, Alinea, Firenze.

Davoudi S., (1999), Sustainability: A new vision for the British planning system, Urbanistica n.112, pp. 76-95.

Deakin M.; Curwell S.; Lombardi P., (2002), "Sustainable Urban Development: the Framework and Directory of Assessment Methods", Journal Of Environmental Assessment Policy And Management (JEAPM), vol. 4, pp.

Figueria J., Greco S., Ehrgott M., eds, (2005), Multiple Criteria Decision Analysis. State of the Art, Springer, USADecreto legislativo, 3 aprile 2006, n. 152, recante "Norme in materia ambientale".

Direttiva 2001/42/CE del Parlamento europeo e del Consiglio del 27 giugno 2001 concernente "La valutazione degli effetti di determinati piani e programmi sull'ambiente".

Gastaldi F., (2002), Esempi di pianificazione strategica in Italia: prime valutazioni, Urbanistica Informazioni, n.183, pp. 41-42.

Greening Regional Development Programmes - GRDP (2006), "Handbook on SEA for Cohesion Policy 2007-2013", febbraio.

Lombardi P., (2007), "The Analytic Hierarchy Process", in Deakin M., Mitchell G., Nijkamp P. and Vreeker R. (eds.), Sustainable Urban Development Vol: 2: The environmental assessment methods, Routledge (GBR)

Lombardi P. and Micelli E., eds. (1999), Le misure del piano, Angeli, Milano.

Muller D., Patassini D., eds. (2005), Beyond Benefit Cost Analysis, Asghate, UK

Nath B., Heans L. and Devuyst D. (eds.) (1996), Sustainable Development, VUB press, Brussels.

OECD - Organisation for Economic Cooperation and Development (1997), Better understanding our cities. The role of urban indicators, Head of Publications Service, Paris.

Palermo P.C. (1992), "Modelli di valutazione e forme di razionalità", in Palermo P.C., Interpretazioni dell'analisi urbanistica, Franco Angeli, Milano.

Pugliesi G. and Spaziante A., eds. (2003), Pianificazione strategica per la città. Riflessioni dalle pratiche, F.Angeli, Milano, pp.249-266

Saaty T. L., Vargas L. G., 2006, Decision Making with the Analytic Network Process, Springer Science, New York.

Saaty T.L., (2005), Theory and Applications of the Analytic Network Process, RWS Publications, Pittsburgh.

Saaty T., (2001), The Analytic Network Process, RWS Publications, 4922 Pittsburgh, PA 15213

Saaty T. L., (2000), Fundamentals of decision making and priority theory with the Analytic Hierarchy Process, RWS Publications, Pittsburgh.

Stanghellini S. and Mambelli T. (2001), "Evaluation of Strategic Programs for the Local Sustainable Development: a Case study", Canavari M., Caggiati P., Easter K.W., eds., Economic Studies on Food, Agriculture and the Environment, Kluwer, Hingham, 2002, pp.269-281.

Therivel R. (1992), Strategic Environmental Assessment, Earthscan Publications Ltd., London.

Therivel R. (1998), "Strategic environmental assessment of development plans in Great Britain", Environmental Impact Assessment Review, vol. 18, n.1, pp. 39-57.

Voogd H., (1983), Multicriteria evaluation for urban and regional planning, Pion, London

Vreeker R., Deakin M., Curwell S. (2008), Sustainable Urban Development Volume 3: The Toolkit for Assessment, Routledge (GBR).

Impact of parking design on the quality of residential life: a case study of residential car parking in Milton Keynes, UK

Dr Shamsul A M A Hoque

Halcrow Group Ltd, UK

For any new residential development scheme the provision of car parking space plays a fundamental role. To improve the quality and sustainability of a development, carefully designing the street layouts and parking is one of the important criteria. In the United Kingdom, it is a common practice that the majority of new residential development schemes provide on-street car parking. Traditionally, these on-street parking spaces should be considered as the additional number of car parking spaces for residents who might already have their individual household car parking space/s, for example as garage, off-street driveway or as a designated group parking area on private road.

However, on majority situations, these garages with 'minimum' width are so inadequately designed that even to get on and off as a driver by only opening the driver side's door becomes very difficult. The house with such a garage forces the vehicle owner/s to park their car/s in alternative parking spaces; i.e., on-street. However, while providing such on-street parking space the layout designer/planner uses minimum street width that can accommodate car parking only on one side of the street instead of on both sides. If the car ownership number per household for that particular area is low then this one-sided on-street parking space could accommodate the required number of car parking spaces. Conversely, on majority of cases this does not fulfil the minimum number. The residents as well as visitors start parking their car on the side walkways (footpaths); i.e., they start parking on the kerbside; hence, blocking the footpath spaces.

Few local authorities in the United Kingdom have detail residential parking standards specified for the number of parking space required for a proposed new residential development scheme. These standards are in terms of the total number of parking spaces in proportion to the total number of housing units in the master plan. In addition, for a very few number of local authorities in the United Kingdom, there are specifications for the minimum size (length and width) of the garage or parking bay specified for the residential neighbourhood. However, for the majority of local authorities, the maximum parking requirement for the new residential development is described as ratio 1:1 or 1:1.5 only; i.e., the number of parking spaces to the number of household units, depending on the number of bed rooms for each household. In practice, to meet these maximum parking requirements sometimes it is easy to produce the master plan that could display the adequate number of parking spaces in layout but in reality, many of those designed car parking spaces are not useable; it is difficult to get out of the car because there is not enough space inside the garage to open the door. As a result, the total feasible parking spaces available to the occupier are reduced from the number of parking spaces originally proposed and later constructed.

In situation where vehicle owners are habituated by parking their car on the kerbside obstructing and even sometimes ignoring the other road users such as pedestrians, cyclists, mothers with pushchairs, people with scooters, moped or wheelchairs who have walking disabilities, etc.; then the question arises whether the quality of life of those residents, who are living in such a newly developed residential neighbourhood, are affected or not? Ultimately, the quality of life by living such a built environment is affected. The quality of life for those residents is accommodating this car driver's behaviour by sacrificing their freedom of accessing their natural rights to enjoy their neighbourhood's street life.

Residents complain about the inadequate parking provision is leading to on-street parking in many new residential development schemes, even leading to neighbour disputes. Using a case study example, Milton Keynes, this paper describes this residential car parking situation.

Keywords: parking standard, quality of residential life, residential development, street planning

1 Introduction

For any new residential development scheme the provision of car parking space plays a fundamental (or key) role. The decision-making process that leads the careful design of street layouts and parking could greatly improve the overall quality and sustainability of a development, MKC (2005). In the United Kingdom, it is a common practice that the majority of new residential (neighbourhood) development schemes provide on-street car parking spaces. Traditionally, these on-street parking spaces should be considered as the additional number of car parking spaces for residents who might already have their individual household car parking space/s, for example – as garage, off-street driveway or as a designated group parking area on private road.

However, on majority situations, these garages with 'minimum' width are so inadequately designed that even to get on and off as a driver by only opening the driver side's door becomes very difficult. The house with such a garage forces the vehicle owner/s to park their car/s in alternative parking spaces; i.e., on-street. However, while providing such on-street parking space the layout designer/planner uses minimum street width that can accommodate car parking only on one side of the street instead of on both sides. If the car ownership number per household for that particular area is low then this one sided on-street parking space could accommodate the required number of car parking space. Conversely, on majority of cases this does not fulfil the minimum number. The residents as well as visitors visiting such an area start occupying the side walkways (footpaths); i.e., they start parking on the kerbside; hence, blocking the footpath spaces.

In situation where vehicle owners are habituated by parking their car on the kerbside obstructing and even sometimes ignoring the other road users such as pedestrians, cyclists, mothers with pushchairs, people with scooters, mopeds or wheelchairs who have walking disabilities, etc.; then the question arises whether the quality of life (QOL) of those residents, who are living in such a newly developed residential neighbourhood, are affected or not?

The author believes the quality of life for those residents are accommodating this car driver's behaviour by sacrificing their freedom of accessing their natural rights to enjoy their neighbourhood's street life. Residents complain about the inadequate and/or inappropriate parking provision is leading to on-street parking in appropriate locations in many new residential development schemes, even lead to neighbour disputes (MKC 2008a). Using a case study example with one of the newly developed popular new towns known as, Milton Keynes, in South of England, this paper analyses such residential car parking situation.

2 Background

Milton Keynes is a unitary authority independent of Buckinghamshire County Council, often abbreviated to MK, an area of 89 sq-km (34 sq miles) within Buckinghamshire county located in South East England, about 45 miles (72 km) North-West of London. The formal designation as a New Town emerges on 23 January 1967. With distinctively unique town planning feature in Milton Keynes, within the urban form uses approximately one kilometre grid following top level street hierarchy principles. As an alternative to the conventional radial pattern road found in other settlements and the other local form of districts is more traditional in nature, this one kilometre interval was chosen so that people would always be within walking distance of a bus stop. In addition, instead of running through communities major (grid) roads in Milton Keynes run between them. The spaces in-between are known as 'grid square', acting as semi-autonomous community ranging from conventional urban development and industrial parks to original rural, pseudo-rural and modern urban developments, Walker (1982).

According to Roger Tym and Partners (2002), Milton Keynes is one of the fastest growing districts within this sub-region, with a very high rate of economic growth. In 2001, population for Milton Keynes Borough was 212,710 (i.e., Census 2001 population figure 207,057 adjusted as described in MKC 2008b). There is a projected potential for an additional 71,000 dwellings (83,359 households, 2001 Census) in the Borough up to 2031, (Roger Tym and Partners 2003a, 2003b).

With so much dedication and humane quality considered during the planning and design stages only just forty-two years ago, now the new generation of development is losing its heritage. The Central Government of UK has asked the Milton Keynes to continue growing as part of its 'Sustainable Communities Plan' (MK Partnership 2005).

Recently, Milton Keynes Council (MKC) has acknowledged (MKC 2008a) that a number of concerns rose by the members and Parish Councils about the level of parking in new residential developments. MK Council has reviewed three development sites and has agreed that two out of three development sites have shortfalls of 34% to 37%, below the recommended minimum 2005 parking standards. In addition, MKC (2008a) points out that the property developers who previously applied the PPG3 principles regarding residential parking standards sometimes resulted in obstructing the vehicular access for Council's refuse collection and day-to-day household items delivery. The situations become worse in terms of vehicular access needed for emergency vehicle such as fire service and ambulance.

Within the new residential development, cars could be parked either on one-side or on both sides of the street, depending on the design and layout of the neighbourhood street. Where residential street has adequate width, it could easily accommodate parked cars on one or both sides. In Milton Keynes, most of the residential neighbourhood 'grid square' as planned during the original master plan have scopes to allow off-street car parking adjacent to the respective household. In addition, where on-street car parking is needed it is possible to park on both sides of the street. With added advantage, local bus could travel through these 'grid square' areas where usages of sustainable transport modes come with virtue. Bus passengers could easily get on and off from designated stoppage areas within their respective neighbourhood streets. Even the individual household has sufficient 'set-back' spaces from the road edge that could allow the extra 'breathing' spaces (e.g. 2.5m or more) between the actual street and the building edge including footway. This breathing spaces enhance the community life by catering the needs for movement in groups, children's playing and other activities and could be used for street furniture and landscaping purposes.

In contrast, many new residential development schemes in Milton Keynes, where the designer keeps the street width to a minimum standard, the street width only allows on-street parking on either side, while designing the residential neighbourhood streets, that often makes people park their cars on the kerb/footpath obstructing movements of pedestrian, bicyclist, mother with child pushchair and especially, people with walking disabilities, e.g. scooter, wheelchair, etc.

In reality, any improper usage would reduce the number of actual car parking spaces available to the residents of this new development. While providing these on-street car parking spaces, the site planner might take the advantage of counting these extra on-street spaces to match up with the 'required' minimum number of car parking spaces for that new development to be accepted during the planning application process. There are no strict policies or sometimes inadequate description on this issue, regarding the minimum number of car parking spaces must be provided within a new development proposal. This relates with the car parking spaces for visitors, tenure occupied households and proportion of share ownership houses/flats.

While providing 'purpose-built' garage (i.e., space designed for car parking) for individual households, the width of such garage is kept so narrow where a Standard-sized private car could hardly be parked inside such garage or driveway. Residents tend not to use this garage as car parking purpose. In majority cases, these garages are transferred to an alternative use as permitted. According to DfT and DCLG (2008) research found that only 44% of garages were used for parking in England. Following a pilot study in one of the new (built within last five years) residential area studies within Milton Keynes, it is observed that out of newly built 106 households/flats, and only around 5 percent of 'purpose-built' garages are used for car parking. Fortunately, these occupants/residents are living in a building that has an irregular shaped garage because of the layout/orientation of the buildings.

The side walls are not parallel but aligned in angular conical way where the front (outside) edge is slightly longer than the back edge. Contrary to these situations, those 'purpose-built' garages and other off-street car parking driveway spaces could be utilised and designed differently not only for car related utility spaces but also for other liveable spaces like garden, lawn, utility or playing spaces for children.

Next in Section 3, a brief methodology followed for this research is presented.

3 Methodology

This is an exploratory research. The paper is mainly based on literature review. In addition, interviews with local residents, government employees, and consultants provide the core of concept formulation for the particular study area. Also the pilot studies on current residents parking facilities of the new residential developments within Milton Keynes are used as secondary data.

It is also observed that Milton Keynes Local Authority has received several complaints and disputes by the members and local Parish Councils related to the residential parking issues as elaborated in Section 1 (MKC 2008a). When residents have to spend time to make a great effort with the driver who parked car improperly or have to negotiate with their neighbours to whom that driver is associated with, then it greatly impacts the personal satisfaction of that particular resident's daily community life. The situation becomes worse when it is a regular event for that neighbourhood. This directly impacts the Quality of Life (QOL) of the resident. As DfT, TRL and IHT (2003) recognises, "that roads are not just arteries for movement but are also used as public spaces and can have a significant effect on community activity and quality of life."

Milton Keynes is selected as the study area because it has started as planned and model New Town in the United Kingdom. According to MKSM 2002 final report (Roger Tym and Partners 2002), Milton Keynes is one of the fastest growing towns in this region in terms of economy and population.

4 Street as a function of community life

For years, the focus of residential street design is dominated to fulfil efficiency of vehicle movement which fails to contribute positively to the quality of residential life. According to DfT and DCLG (2008), well-designed streets play a vital part in the delivery of sustainable communities; where sustainable communities defined as - 'places where people want to live and work, now and in the future', ODPM (2005). DfT, TRL and IHT (2003) noted, "It is important to recognise that roads are not just arteries for movement but are also used as public spaces and can have a significant effect on community activity and quality of life."

The term ‘Quality of Life’ (QOL) used here to identify the subjective qualities of the life style enjoyed by the local residents in a neighbourhood community. These qualities could depend on many indicators; in 2005 the Economist Intelligence Units defined a QOL index based on information on nine selected factors collected from 111 countries and territories; The Economist (2005). Although the Economist Intelligence Units used a unique method to define the QOL index; however, out of their nine factors, community life is one of them. While looking for an acceptable definition and indicator/s of ‘quality of life’, Wikipedia (2009) states, “debate on quality of life is millennia-old, with Aristotle giving it much thought in his *Nicomachean* Ethics and eventually settling on the notion of *eudaimonia*, a Greek term often translated as happiness, as central. The neologism liveability (or livability), from the adjective *liv(e)able*, is an abstract noun now often applied to the built environment or a town or city, meaning its contribution to the quality of life of inhabitants.” According to the online Dictionary (2009) the quality of life defines as ones personal satisfaction (or dissatisfaction) with the cultural or intellectual conditions under which he/she lives (as distinct from material comfort). UEM (2009) provides a definition of quality of life, “The degree to which a person enjoys the important possibilities of his/her life. Possibilities result from the opportunities and limitations each person has in his/her life and reflect the interaction of personal and environmental factors.” Here in this paper the term ‘Quality of Life’ is used to link with the subjective qualities of daily life which might have positive impact when an inhabitants enjoys satisfactory car parking facilities in his community and the vice versa.

From text book context, roads can be categorised into five tiers – a) Primary Distributor b) District Distributor c) Local Distributor d) Access Road, and e) Pedestrian Street, complemented by walking and cycling routes. With recent movements, (Jones, Boujenko and Marshall 2007), this traditional understanding is redefined by developing new approach to street planning and design, depending around the dual functions of streets as ‘Links’ (movement conduits) and as ‘Places’ (destinations in their own right).

According to Manual for Streets (MfS) report (DfT and DCLG 2008), roads are fundamentally highways whose main function is accommodating the movement of motor traffic. Streets are typically lined with buildings and public spaces, and while movement is still a key function and place function is the most important among the four others. Jones, Boujenko and Marshall (2007) shows, “Streets are the lifeblood of our towns and cities, and are used for a multitude of activities: for the movement of people and goods, for parking and loading, and for a variety of civic, social and economic activities. Street planning is about much more than just providing good transport infrastructure; it is also about quality ‘place making’, supporting liveability, urban vitality and sustainability.” According to CABE and ODPM (2002), there are five principal functions of streets – i) place, ii) movement,

iii) access, iv) parking and v) drainage, utilities and street lighting. MfS report adds that streets have to fulfil these functions to meet people's need as place of living, working and moving around in.

Here in Milton Keynes residential neighbourhood, streets are mainly with 'Access Road' category. In terms of Urban Safety Management (USM), the designing of such 'Access Road' needs to consider that vehicle making regular collections and deliveries; access and egress for emergency vehicles; for pedestrians and cyclists; to provide appropriate surroundings for the frontages' homes and other premises. In addition, DfT, TRL and IHT (2003) states, "...it is important to ensure that particular attention is paid to pedestrian traffic and more priority given to pedestrian movements, especially around residential and shopping areas". The study provides USM principles for good road safety strategy considering – all kinds of road users, i.e., especially vulnerable road users and functions of different kinds of road. The report further states that not all roads are the same; this role is played by each category of road that depends on the hierarchy of road.

3.1 MK car parking demands and standards

According to PPG3 (DETR 2000), the national parking standard for residential development scheme, gives a maximum average ratio of 1:1.5 off-street car parking spaces to the total number household proposed any new residential development.

While researching on car ownership and parking demand in DCLG (2007) stated that although the car ownership is lower in the UK than the average for the European Union or in other similarly-developed countries; however it is likely to continue growing in near future. In addition, 1.78 car ownership growth factor shows when using TEMPRO 5.0 forecast, for Milton Keynes Authority. Faber Maunsell (2003) report states that "Milton Keynes has often portrayed as a city designed for the car". The car ownership rate of 1.26 cars per household, Milton Keynes is one of the highest car ownership districts of similar sized cities in the UK. According to MKC (2008a), the average car ownership in Milton Keynes was 1.26 per household in 2001, 1.32 in 2008 and 1.49 in 2026; whereas for Great Britain the figure was lower, i.e., 1.1 in 2001.

DCLG (2007) states the following factors have significant influence on car ownership and car parking demand –

Dwelling size, type and tenure

Dwelling location

Availability of allocated and unallocated parking spaces

Availability of on- and off-street parking

Availability of visitor parking and

Availability of garage parking

The allocations of car parking spaces to individual dwellings can have adverse impact on the efficiency of car parking provision. The term 'allocated' parking spaces as defined by the research DCLG (2007) includes spaces within the area immediately surrounding a property (e.g. garage or driveway parking) and spaces in communal areas where the space is reserved for one particular property. It also states that the on-street spaces upon public highways are always unallocated; however, they can be reserved for a particular purpose like parking with physical disability. Even the national policy parking standard suggests not considering these on-street car parking spaces within the required minimum number.

MKC (2008a) describes clearly about the car parking requirements for the new residential development proposals. These are as follows:

"Car parking provision must not exceed the Council's maximum standards.

On-site parking should not be reduced below the maximum standard if it would be likely to result in off-site parking causing problems that cannot be resolved by on-street parking controls.

Parking areas should be well designed in terms of safety, circulation and appearance and assist access by pedestrians and cyclists."

It is understood that MKC is aiming to increase the usage of sustainable transport modes and at the same time focusing to reduce the private car usage. Following MKC policy for the number of parking requirement for any proposed new development where provision must not exceed the Council's recommended maximum, there might be situations where there are demands for additional parking spaces but because of that 'maximum' standard it is not always possible to provide more.

In addition, as MfS (DfT and DCLG 2008) recommends counting car ports towards the total number of parking provision for the residents, because car ports are unlikely to be used for household storage. However, the point raised on this particular issue is that, it is understood car port would not be used as storage space but to make use this car port as garage, the inside dimension of that car port should fit the standard vehicle size, otherwise that car port would remain under-utilized forever. Contrary, to increase the efficiency, many authorities are now recommending larger garages to accommodate both storage and car parking with a recommended minimum size of 6m by 3m; (DfT and DCLG 2008).

Similarly, for rented household the standard can be up to 0.5 fewer cars than owner-occupied households in similar size and type (DCLG 2007). In line with this, for rented residential households parking standard that is smaller than those of owner-occupied households, there are scopes this smaller number might be considered by the developers for new shared ownership scheme. Even to match the parking standards often for shared ownership housing schemes in Milton Keynes, these on-street car parking spaces might have counted within the 'required' numbers of car parking spaces per household instead of 'additional' or 'unallocated' car parking spaces. The outcome often emerges as not fulfilling the basic standard.

The following section explain briefly the street or road designing criteria-

3.2 Street design criteria

The MfS recommends (DfT and DCLG 2008) the design consideration that must be followed the road/street user hierarchy with pedestrian at the top, as presented in Table 1. The manual recognises the importance of the community function of streets as spaces for social interaction, the needs of people of all ages and abilities. It is noted that this user hierarchy is not rigidly maintained, however, the process must considered all the users, especially pedestrian must be considered first.

Table 1: User hierarchy

	Priority	**Types of road users**
1st	Consider First	Pedestrians
2nd		Cyclists
3rd		Public Transport users
4th		Specialist service vehicles (e.g. emergency, waste)
5th	Consider Last	Other motor traffic

Jones, Boujenko and Marshall (2007) explains new approach of street planning. Accordingly, the street planning starts with the development of a Link/Place street classification as shown in Figure 1. Within the matrix, each cell represents a particular type of street with a specific combination of a Link and Place status level in urban area. This Link/Place matrix provides a comprehensive approach recognising how street functions and how street should be designed to cover the all types of user needs.

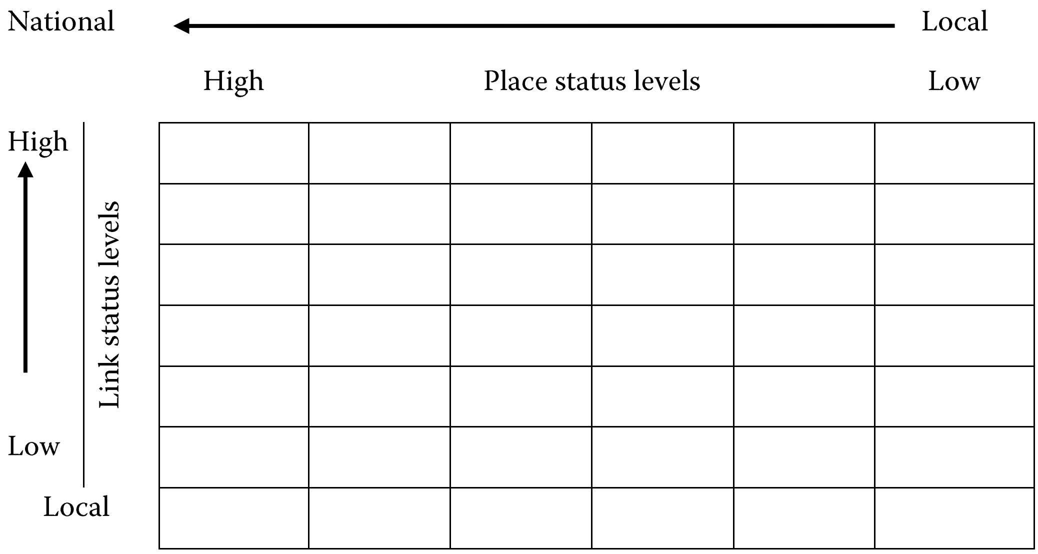


Figure 1: New approach to street planning and classification

According to Jones, Boujenko and Marshall (2007), street planning and design can contribute to the following five general policy areas:

Liveability: by ensuring streets are valued public spaces, not just places to be quickly passed through or avoided, by making them clean, safe and attractive environment.

Urban design quality: by creating places of quality that people will take pride in and enjoy observing and using in their own right.

Sustainability: street planning and design would encourage more sustainable travel patterns.

Social Inclusion: streets are physically and culturally accessible to all, needs of different user groups are acknowledges and catered for.

Vitality and viability: promoting lively and economically successful places through the location, format and design.

This shifting from a traditional roads-based approach to a streets-based approach to planning and design is encouraging by the Department for Transport (DfT). Following section is describing the residential parking policy for Milton Keynes.

5 Parking policy context for MK

Few local authorities in the United Kingdom have detail residential parking standards specified for the number of parking space required for a proposed new residential development scheme. These standards are in terms of the total number of parking spaces in proportion to the total number of housing units in the master plan. However, for the majority of local authorities in UK, the maximum parking requirement for the new residential development is described as ratio 1:1 or 1:1.5 only; i.e., the number of parking spaces to the number of household unit, depending on the number of bed rooms for each household. In addition, for a very few number of local authorities in UK, there are specifications for the minimum size (length and width) of the garage or parking bay specified for the residential neighbourhood plan (Hants 2002).

In practice, to meet these maximum parking requirements sometimes it is easy to produce the master plan which could display the adequate number of parking spaces in layout but in reality, many of those designed (shown on layout) car parking spaces are not useable; it is difficult to get out of the car because there is not enough space to open the door. As a result, the total of feasible parking spaces actually available to the occupier reduces from the total number of parking spaces originally proposed and compared to the number later constructed.

In terms of Milton Keynes, while designing the new residential development scheme, building designers and developers provide only the 'bare minimum' dimension for the 'purpose-built' garage as the local planning authorities (i.e. development control authorities) do not have any set standard specified in the parking standards, for the minimum width or length of such a 'purpose-built' garage. Usually, the residential parking standard is specified as the ratio of number of car parking spaces per dwelling, categorised the parking standards depending on the number of bed rooms per household (MKC 2005). Usual practice is to provide the garage space to fulfil the minimum requirement while getting approval from the local planning authority. Once the new scheme is approved and get built, no one take into account the ultimate usage of that garage space when the house will be occupied by the residents in future. In reality, if the garage is not used as designed, then the car owner will keep their car in the adjacent road space, if no restriction applies. This would reduce the efficient usage of the street space in that neighbourhood. The national research on car parking studies showed that less than one third of respondents parked their cars in their garages (DCLG 2007).

With more awareness is growing concerning provision of parking and how to make people to use more environments friendly and sustainable transport modes. The next section is making a brief description how the policy is changing in near future.

6 Future Direction

Recently a number of local authorities, including London are considering updating their existing parking standards. Previously, in Milton Keynes PPG3 guidelines were used regarding car parking standard that advocated a maximum provision of 1.5 off-street parking spaces per dwelling. Currently, PPS3 (Planning Policy

Statement 3) approach is adopted, where a more emphasis is placed on local circumstances considering expected levels of car ownership, the importance of promoting good design and the need to use land efficiently, (DCLG 2006).

It is noticeable the awareness is constantly growing of the need for integrated design in urban areas; especially, this applies the integration of traffic, roads and different land uses. This includes the interplay of the physical appearances, layout of the buildings and roads. Bartlett (2006) states, "An urban architect who designs an attractive facade but ignore the material used to build the adjoining roads and footpaths has failed in his work."

Age Concern (2007) is trying to raise the issue to introduce a mandatory code for sustainable homes in UK. In addition to these, following essential sustainability criteria in the code, for example – energy/CO2, water, materials, surface water run-off, waste, household and site waste; there would be optional criteria like – pollution, health and well-being (including Lifetime Homes), management and ecology. Once this has become part of the house building policy, then developers would be required to indicate to any prospective buyer whether their (developer) home has been assessed against the Code.

Of course this depends on cultural habit and making a change is not possible overnight. Using a garage depends on adequacy of storage within the dwelling, the ease of use of the garage and the availability of finding alternate parking space outside the garage. Local planning authorities encourage approaches where residential development schemes provision of car ports or driveway spaces are provided instead of enclose garages that might be used as storage.

7 Conclusion

This paper is an attempt to present the current practices of household parking provisions while designing the new residential neighbourhood schemes. Although, this article only highlights the situations for Milton Keynes as a popular new town example, however, for future studies there might be scope to extend the study outside the boundary of this geographical area.

Among the planners and associate professionals, there is a growing awareness for providing quality street design and layout including parking in new residential neighbourhood development proposals. Many local authorities in UK are either, updating or in the process of changing their local and residential parking policies and standards. Once the respective policies and standards are in place, those (policies and standards) are followed, adopted and practiced by the respective professionals, finally monitored and feedback by the local authorities, then the quality of the neighbourhood community life, including built environment, would become more enjoyable and participatory.

8 References

Age Concern (2007) Age Concerns' response to 'The future of the Code for Sustainable Homes - making a rating mandatory', Policy Responses, Reference: 4007, October 2007, UK..

Bartlett, R (2006) Urban Best Practice Chapter 001: Germany, Urban Paving, version 1.2, Schorrell Analysis December 2006. http:\\www.Transportworldwide.com\UrbanBestPractice.pdf accessed October 2008.

CABE and ODPM (2002) "paving the way how we achieve clean, safe and attractive streets". by Commission for Architecture and the Built Environment (CABE) and the then Office of the Deputy Prime Minister (ODPM), Thomas Telford Ltd., London.

ONS (2001) Census 2001 online, The Office for National Statistics (ONS), UK.

DCLG (2006) Planning Policy Statement 3 (PPS3) Housing, The Department for Communities and Local Government (DCLG), November 2006, London.

DCLG (2007) Residential Car Parking Research, The Department for Communities and Local Government (DCLG), May 2007, London.

DETR (2000) Planning Policy Guidance Note 3: Housing (PPG3), Department of Environment Transport and the Regions (DETR), March 2000, UK.

DfT and DCLG (2008) "Manual for Streets". The Department for Transport (DfT) and The Department for Communities and Local Government (DCLG), UK.

DfT, TRL and IHT (2003) "Urban Safety Management Guidelines" Road Safety Strategies for Urban Communities, jointly prepared by the Department for Transport (DfT), Transport for London (TRL), and The Institution for Highways and Transportation (IHT).

Dictionary (2009) online http://www.thefreedictionary.com/quality+of+life accessed 15th April 2009

Faber Maunsell (2003) Milton Keynes Long Term Public Transport Vision Study, November 2003, Milton Keynes Council and English Partnerships.

Hants (2002) Hampshire Parking Strategy and Standards, Spring 2002, Hampshire County Council (Hants), UK.

Jones, P, Boujenko, N and Marshall, S, (2007) "Link & Place: A Guide to Street Planning and Design". Local Transport Today Ltd., London, UK.

MK Partnership (2005) "Milton Keynes 2031 A New Plan for Milton Keynes". Edition 1, published May 2005, Milton Keynes (MK) Partnership.

MKC (2005) Parking Standards For Milton Keynes, Supplementary Planning Guidance, Planning and Transport, Environment Directorate, Milton Keynes Council (MKC), January 2005, UK.

MKC (2008a) Consultation Document for the Review of Residential Parking Standards in Milton Keynes, Highway Development Control, December 2008, UK.

MKC (2008b) Population Bulletin 2008/09, the figure adjusted from Census mid-year June 2001 count by Milton Keynes Council, UK.

ODPM (2005) Planning Policy Statement 1: Delivering Sustainable Developments, by the then Office of the Deputy Prime Minister (ODPM), London: TSO.

Roger Tym and Partners (2003a) "Milton Keynes Growth Area Study - Executive Summary", May 2003, by Planners and Development Economist, Halcrow and Three Dragons, UK.

Roger Tym and Partners (2003b) “Milton Keynes And Aylesbury Growth Area Study – Draft Final Report”, May 2003, by Planners and Development Economist, Halcrow and Three Dragons, UK.

Roger Tym and Partners (2002) “Milton Keynes and South Midlands - Final Report of the Study”, September 2002, by Planners and Development Economist, Halcrow and Three Dragons, UK.

The Economist (2005) "The Economist Intelligence Unit’s Quality-of-Life Index", The World in 2005. citied in http://en.wikipedia.org/wiki/Quality_of_life_index.

UEM (2009) online resource from the Urban Environmental Management (UEM) website, http://www.gdrc.org/uem/qol-define.html accessed April 2009. cited in Quality of Life Research Unit, University of Toronto, Canada.

Walker, D (1982) “The Architecture and Planning of Milton Keynes”. London: Architectural Press. pp. 8. cited in Clapson, M (2004) “A Social History of Milton Keynes: Middle England/Edge City”. London: Frank Cass. pp. 40.

Wikipedia (2009) online http://en.wikipedia.org/wiki/Quality_of_life. cited in http://www.selfgrowth.com/articles/Definition_Quality_of_Life.html, accesses April 2009.

Acknowledgements

The author expresses his gratitude to his work colleagues, Mr. Tim Lund, Mr. Martyn Brooks, Dr Robin Hickman and Dr Paul Read of Halcrow Group Limited, for providing necessary supports to prepare and present this paper. In addition, the author puts across his sincere appreciation to his ex-colleague Mr. Nigel Weeks, Stirling Maynard Transportation (SMT), Milton Keynes, and Dr Nobbir Ahmed for his support to complete this paper.

Anything written and presented in this paper are those of the author alone and DO NOT necessarily representing the views either of his current employer, Halcrow Group Ltd or of ex-employer, Stirling Maynard Transportation (SMT).

Environmental impact assessment as a tool for urban environmental planning and management in Brazil – a case of a mid-sized city

Dr Marcelo Montano, Dr Marcelo Pereira de Souza

University of São Paulo, Brazil

Environmental management strategies have undergone overwhelming advancement in recent years, propelled by State actions (regulator and supervisory agent), and supported by the general public's requirements.

Although going to be banned from the industrial sector even in developing countries, due to acknowledged high costs involved, the end-of-pipe approach is usually applied to cities (meaning corrective actions rather than preventive ones), and the practice of environmental management in urban areas has shown to be unable to prevent environmental impacts, so as to guarantee a basic level of environmental/life quality.

In Brazil, mechanisms of governmental control are clearly inefficient and public managers in general lack the experience to use environmental planning tools, hence contributing towards the deterioration of environmental quality at the moment of an urban sprawl or any other activities associated to urban development. Basically, there is an instrumental vision regarding the role of cities in people's lives, and environmental issues are normally overlooked when a set of priorities are established by economic development requirements, leading to environmental liabilities and distancing the cities from a sustainable pathway.

This paper proposes the adoption of a differentiated approach to be applied in urban environmental planning and management. It is quite similar to an Environmental Impact Assessment (EIA) process and to some of its procedures, considering the whole city as an enterprise, with its inputs and outputs. In doing so, the flows of matter and energy define the major aspects to be considered on assessing the impacts caused by development projects, at least from the Environmental Agency's point of view.

The paper brings a case study of a mid-sized city in the State of São Paulo, Brazil, and describes the processes involved in the EIA – identification, prediction and evaluation of impacts, as well as their usual mitigation measurements. While it recognizes a major limitation of this approach in dealing with the implications related to socio-economic processes, it is believed that this proposal can contribute to improve the environmental performance of cities.

Keywords: environmental management, impact assessment, urban sustainability

1 Introduction

The environmental management strategies have undergone overwhelming advancement in recent years, propelled by State actions (regulator and supervisory agent), and supported by the general public's demands.

Traditionally, environmental issues are addressed by a set of end-of-pipe solutions, which takes pollution as a normal consequence of the development process. This approach usually means high initial investment solutions as well as operating and maintenance costs, and often does not guarantee the expected results. Therefore, end-of-pipe technologies have been gradually set aside as immediate solutions for dealing with environmental issues, especially on account of the need to meet new performance requirements through the initiative of organizations or by virtue of enacting more restrictive laws. (Souza 2004; Jones et al 2005; Brand, Thomas 2005).

The scope of environmental debates did not include urban issues within the structuring of the sustainable development discourse, at least at the beginning. Cities did not appear as particularly important in the major reports, such as Meadows et al (1972) or the United Nations Conference on the Human Environment in Stockholm in 1972 (Brand, Thomas 2005).

However, the population explosion became a specifically urban explosion during the twentieth century (Hassan, Zetter 2002). Thus, the Brundtland Report (1987) argued that the world's population would concentrate in towns, cities and metropolis throughout the Earth. However, the deficiencies of (at that time) Third World cities in terms of administrative strength, economic resources and skilled personnel were held to be incommensurate with the scale of needs produced by rapid growth and squatter developments, worn-out infrastructure and congested transport facilities. Despite the potential benefits of urbanization, cities of developing countries can rarely afford the costs that this process imposes.

In Brazil, mechanisms of governmental control are clearly inefficient and public managers lack the experience of applying environmental planning tools, hence contributing towards deteriorating environmental quality at the moment of an urban sprawl or any other activities associated to urban development (Souza 2004). Basically, there is an instrumental vision regarding the role of cities in people's lives, and environmental issues are normally overlooked regarding a set of priorities established by economic development requirements, leading to environmental liabilities and distancing the cities from a sustainable pathway. Thus, environmental agendas need to be implemented to introduce the environmental issues to the decision making framework (Zetter, White 2002). To this respect, nowadays the lobbies are seen as a "joint-venture" of political parties and economic interests, and this practice constitutes an important point to considerer in the decision making process (Rydin 2003).

Bell and Morse (2008) mention that one way to measure the presence of environmental issues in the cities' planning and practice is by sustainability indicators, including scenario studies, stakeholder's participation, introducing the systematic sustainability analysis approach. In a similar manner, Gibson et al (2005) add some sustainability requirements as the basis for decision making.

In this perspective, the environmental impact assessment as an Environmental Policy tool must be incorporated into the decision making process.

2 Urban environmental planning and management.

According to Hall (1992), different approaches have been used to incorporate environmental issues into urban planning and management. In this sense, it can be seen that each different knowledge area has intended to demonstrate that its theoretical conceptions are correct and, from rational planning, lead to better living conditions in urban areas.

As Souza (2004) states, the planning process of cities is criticized by those who want to "denaturalize" the analysis of producing the urban space, classifying it as a socially-oriented process with problems caused by the dynamics of wealth production and the structures of power observed in modern societies, and also by those who recognize the limitations of governments to avoid critical situations in terms of life quality (this vision is strengthened by the limitations of a typical welfare-state planning, easily recognized nowadays).

There is clearly a confrontation between social sciences and what is criticized as an “objective” or “cartesian” approach to urban planning and management, strengthened when dealing with environmental questions (Polèse, Stren 2000).

Giddens (2001) and Foladori (2001) observe that the global environmental crisis is, to a large degree, a consequence of the contradictions observed in a capitalist society around the means of production. Thus, a technical reductionism would not appropriately address environmental questions. Foladori (2001) is quite direct when stating that "technical solutions never solve the problem of social contradictions, but most of the time make them worse" (pg 137). According to them, a technically-based development is related to a continuously negative trajectory that is unable to mitigate the mentioned contradictions.

In fact, environmental problems are always linked to social effects. But resorting to natural resources for human life, caused by drastic changes on environmental systems, cannot be ignored. Therefore, the technical approach still remains useful for urban planning and management, in order to assess the impacts over the environment and to incorporate certain limitations to their occurrence.

It means to recognize and to admit as valid the conception of a city – or parts of it – as a dynamic system that is inter-related to others, which have their support basis sustained by different flows of matter and energy. Indeed, a great challenge to public administrators and to the general population is coupling the production of social space to the environmental dynamics that occur within the urban context. The cities, are responsible for a wide range of environmental effects that must be integrated to their management strategies. Although remote from most ecological fundaments that rule natural systems, the urbanization process implies in modifications of the ecological borders, with intense importation and exportation of matter and energy.

As Odum (1998) observes, as a system increases in terms of dimension and complexity, the energetic cost of maintenance tends to rise proportionality in order to reduce the entropy growth. Applied to the urban system, this means higher social and environmental costs, as well as the economic aspects.

Traditionally, environmental management applied to the urban context has been characterized by a conflict in decision-making processes, which means an overlap of "urbanistic interests" (in essence concerning structural and functional issues) over the environmental ones. This involves different motivations surrounding the maintenance of power structures and, in some ways, reveals a great misunderstanding about the process of urban planning and management focused on environmental issues, as well as the role of different actors within it. (Polèse, Stren 2000; Zetter, White 2002; Brand, Thomas 2005; Rydin 2003).

3 Environmental Impact Assessment and applications

An Environmental Impact Assessment (EIA) involves the evaluation of the effects likely to arise from a major project (or other actions) significantly affecting the environment. It is a systematic process for considering possible impacts prior to a decision being taken on whether or not a proposal should be given approval to proceed (Morris, Therivel 2001; Glasson 2005; Jay et al. 2007).

As Jay et al. (2007) point out, current studies criticising EIA as an essentially techno-rational approach to decision-making have increased among researchers and practitioners. When it was developed, the rationalist thinking supremacy concept was in place, bringing the idea of supporting decision-makers to provide objective considerations to an issue, taking into account possible alternatives, each of which were previously assessed on the basis of the available technical information, and linking it to a final decision that was taken in the best interest of society as a whole.

After almost 40 years of practice, EIA procedures have been strengthened and EIA capacity has been improved in different contexts of development. However, it is acknowledged that the instrument is limited in reaching its full potential, which means exerting influence over development decisions. Wood (2003), in a comparative review of seven EIA systems around the world, concluded that to a certain degree, EIA does exert influence on development decisions, but that it is common for the findings of EIA to be shadowed by other considerations, such as non-environmental objectives and political factors. He found that, for all seven systems, EIA generates modifications to project designs, prior to formal applications and/or during formal EIA processes, but that these are generally minor and designed to mitigate the worst effects of development.

Nowadays it is recognized that, in countries with mature EIA systems, there is some agreement about the need to improve EIA outcomes (Barker and Wood 1999; Wood 2003; Christensen et al. 2005; Jay et al. 2007). The limitations on contributing to sustainable development, considering the results verified so far, encourage the inclusion of environmental, political, societal and economical issues with the same basis of assessment. Therefore, a great diversity of instruments can be seen, such as Social Impact Assessment, Health Impact Assessment, Strategic Environmental Assessment, and also Sustainability Assessment - each one working within a specific focus, but all of them sharing an empty space that EIA could not fill satisfactorily.

Some EIA systems allow for different approval mechanisms to be used for different projects, according to Ahmed and Wood (2002) "without placing a heavy burden on the competent authority". This strategy is applied in several countries (Wood 2000), leading to a "full EIA" process, a "scoped EIA" with simplified procedures, or even a simple approval mechanism by submitting an application form.

In Brazil, EIA is formally linked to the environmental licensing processes, conducted by governmental agencies, and is applied to verify what is called "environmental acceptability" of the proposed activities. In fact, the role played by EIA process is focused on the discussion about the changes introduced by the projects and on the quality of some environment components, guided by legal requirements.

One of the major deficiencies of the Brazilian EIA system is the low degree of commitment with the follow-up and monitoring procedures. As Sánchez (2006) appoints, there is a huge discrepancy between the rigor applied to the identification and assessment of impacts and the level of interest (surprisingly small) to check if the project was implemented in accordance with the requirements and if mitigating measures reached their environmental protection goals.

4 The project-EIA approach: the cities as enterprises.

The process of urbanization has been referred to as a major source of significant environmental impacts of anthropogenic origin, both in magnitude and in extension. In fact, urban settlements have been crucial to the deterioration of environmental quality regarding physical, biological and socioeconomic aspects.

Scientific literature attributes to urbanization a series of environmental impacts: pollution and contamination of surface and ground water resources by point or diffuse sources, air pollution, altering water characteristics from rain, erosion and soil contamination, removal of vegetation, displacement of wildlife, changes in the socio-economic conditions, various impacts on local populations, changes in micro and meso climates, and so on. (Characklis, Wiesner 1997; Zandbergen 1998; Pauleit, Duhme 2000; Sutherland, Tolosa 2000; Luria, Aspinall 2003; Zannin et al 2003; Sullivan et al 2004).

However, there are several dominant interests (economic/politics) deciding and establishing a considerable conflict among the stakeholders. In order to contribute to address these conflicts, and considering the conceptual framework of Environmental Impact Assessment (Canter 1996; Morris, Therivel 2001; Glasson et al 2005), the present paper proposes to apply to the cities (and to the public activities) the same approach applied to project-EIAs, establishing a set of requirements to be achieved by the projects, in terms of their environmental performance and taking into account legal and social requirements.

According to this approach, the environmental effects caused by the city's development could be better controlled following the systematic framework of assessment and management given by EIA procedures, which means:

- A normative control, imposed by legal requirements, quite similar to a licensing process. In Brazil, the legal framework given by the National Environmental Policy (Law 6.938/1981 and followed by the National Environmental Council resolutions) sets the environmental licensing as a process to verify the acceptability of projects previous to construction, and to control the environmental effects throughout their life cycle;
- A voluntary control, applying certain instruments already widely disseminated in the private sector, as certifications and auditing. Certifications are coupled to an Environmental Management System implemented to inspect objectives and targets given by the organization's Environmental Policy.

In both cases, controlling mechanisms will be more effective when coupled to a systematic assessment of environmental impacts caused along the different stages of urbanization processes, considering the procedures of the Environmental Impact Assessment.

The central aspect is to visualize the city (and all of its components) as a "single" enterprise, with flows of matter and energy and related environmental impacts. As a consequence, public administrators are responsible for them and, similar to private enterprises, there are some environmental performance requirements to be achieved.

According to the operational principles presented by IAIA (1999), the present paper suggests the application of an EIA process in compliance with the following steps:

- Screening: to determine whether or not a development project should be subjected to EIA and what level of detail, within the cities' context, it implies in different approaches that range from simplified approval mechanisms up to a "full EIA" process, depending on the impact potential;
- Scoping: to identify the issues and impacts that are likely to be important, for instance - water and air pollution, noise, spatial segregation;
- Examination of alternatives: to establish the preferred or most environmentally sound and benign option for achieving proposal objectives;
- Impact analysis: to identify and predict the likely environmental, social and other related effects of the development projects and/or urban equipments;
- Mitigation and impact management: to establish the measures that are necessary to avoid, minimize or offset predicted adverse impacts and, where appropriate, to incorporate these into an environmental management plan or system;
- Evaluation of significance: to determine the relative importance and acceptability of residual impacts (i.e., impacts that cannot be mitigated);
- Preparation and review of environmental studies: to document clearly and impartially impacts of the proposal, the proposed measures for mitigation, and the concerns of the interested public and the communities affected by the proposal, determining whether a satisfactory assessment was provided;
- Decision making: to approve or reject the proposal and to establish the terms and conditions for its implementation - with an adequate level of public participation;
- Follow-up: to ensure that the terms and conditions of approval are met; to monitor the development impacts and the effectiveness of mitigation measures; and, where required, to undertake environmental audit and process evaluation to optimize environmental management.

The project-EIA in general is supported by a characterization of different flows of matter and energy associated to the activities or enterprises, in order to identify and evaluate the level of impact to be caused. Considering the city as a single enterprise, EIA must focus on “urban elements/equipments” (for example, associated to the surface drainage system, transport, solid waste, and so on) and the impacts associated to them.

It must be highlighted that some urban elements, before their implementation, are subject to an environmental licensing process that must verify their environmental acceptability (or viability) before it is concluded. In Brazil, the environmental licensing follows a three-step process - Previous Licence, Implementation Licence and Operation Licence. Regarding this, two observations must be made:

- It is necessary to assess whether the environmental licensing concerning these elements/ equipments has been effective in ensuring its environmental viability and legal compliance;
- The Brazilian environmental licensing system does not give to urban equipments, in general, the same status given to other activities (except in case of specific regulation, as seen with solid waste landfills, sewage treatment plants and, in certain situations, industrial districts) which means an absence of systematic monitoring and verification of environmental performance throughout their lifecycle.

Based on empirical observations, the case of a medium-sized Brazilian city is discussed.

1. A case: São Carlos city – Brazil.

São Carlos is in the central region of São Paulo state, with a surface of 1.140 km^2, from which approximately 70 km^2 constitutes its urban area. Its population is of about 220.000 inhabitants, with an annual growth of 2%. It is a typical city undergoing high levels of industrial and agricultural development.

Table 1 shows the results of a screening step for an EIA process, as determined by ordinary licensing guidelines.

Table 1: Screening step for the EIA-licensing process applied to urban elements

Urban elements	**Mechanisms of approval**
Urban mesh (residential and/or commercial areas)	Simplified mechanisms (normal and without environmental issues). Scoped-EIA (rare) Full-EIA (very rare)
Industrial districts	Scoped-EIA Full-EIA (rare)
Urban solid waste management system	Full-EIA
Transport infrastructure	Simplified mechanisms
Wastewater system (treatment plant)	Scoped-EIA
Wastewater system (infrastructure)	Simplified mechanisms
Surface drainage	Simplified mechanisms

Following a formal EIA process the scoping stage results in a set of questions related to the main impacts expected to be considered in the environmental studies and therefore in decision making. These impacts can be described, in general, as shown in Table 2.

Table 2: Urban elements and main impacts expected over environmental components

Urban elements	Phase/stage	Main impacts
Urban mesh	Construction	Loss of native vegetation, changes in runoff conditions, soil loss (erosion) and sediment transport/siltation, reduction of soil permeability
	Operation	Reduction of soil permeability, climate change (micro and meso scales), noise, water/groundwater/air/soil pollution (diffuse and punctual), spatial segregation
Industrial Districts	Construction	Loss of native vegetation, changes in runoff conditions, soil loss (erosion) and sediment transport/siltation, reduction of soil permeability
	Operation	Water/groundwater/air pollution, soil contamination
	Close-down	Water/groundwater/air pollution, soil contamination
Urban solid waste management	Construction	Loss of native vegetation, soil loss (erosion) and sediment transport/siltation
	Operation	Water/groundwater pollution, soil contamination
	Close-down	Water/groundwater pollution, soil contamination
Transport infrastructure	Construction	Interference on protected areas (Permanent Preservation Areas), soil loss (erosion) and sediment transport/siltation
	Operation	Water/air pollution (diffuse), noise
Wastewater system (treatment plant + infrastructure)	Construction	Interference on protected areas (Permanent Preservation Areas), soil loss (erosion) and sediment transport/siltation
	Operation	Water/groundwater pollution (in case of disruption of pipelines), soil loss (erosion) and sediment transport/siltation
Surface drainage	Construction	Interference on protected areas (Permanent Preservation Areas), soil loss (erosion) and sediment transport/siltation
	Operation	Water pollution, soil loss (erosion) and sediment transport/siltation

Given the situation verified in the study area in terms of environmental impacts related to the elements described, São Carlos can be taken as a representative city from the totality of Brazilian mid-sized cities.

Without a single exception, the impacts described at Table 2 are easily verified in field surveys. Depending on where they occur, the negative effects can assume a dramatic perspective – the more fragile the environmental conditions are, the worse the effects to be caused. Figures 1 to 4 (recently taken by the authors), can illustrate the situation. They reflect different types of failures in the licensing/controlling system, which is showed to be unable to deal with the impacts along the whole life cycle of urban equipments or elements.

Figures 1 and 2 shows a situation of impacts over surface water and over legal preservation areas near the city's centre, following the disruption of a wastewater pipeline (Figure 1) and along a bridge construction (Figure 2). In these cases, the EIA procedures would provide to decision-makers information to properly respond to this situation, in terms of prevention and mitigation of the impacts to be caused. A private enterprise, in a same situation, could receive some administrative penalties.

Figures 3 and 4 illustrate the lack of concern of public administrators with environmental impacts along time. The irregular disposal of solid waste (Figure 3) implies, in most of the cases, in impacts like water and soil pollution that can be transformed in serious threats to public health. At the same way, Figure 4 shows a typical drainage solution applied in the city – the problem here is limited to remove the runoff without considering the impacts to be caused.

Figure 1: disruption of a wastewater pipeline

Figure 2: construction of transport infrastructure and impact over Permanent Preservation Areas – soil loss and siltation at urban streams

Figure 3: irregular disposal of solid waste

Figure 4: surface drainage equipment causing erosion and degradation in streams

What is seen is that although the licensing process brings some specific legal requirements to control the impacts to be caused, it has to be improved in order to increase the commitment by the managers with their environmental objectives and responsibilities.

One of the main questions is that, unlike private enterprises and their duty to respond to governmental agencies, the city (and urban elements/equipments as well) seems to be no one's property. Especially for “intra-urban” elements (transport infrastructure, urban mesh, and elements of surface drainage), the actions by the environmental agencies are not as effective as what is true for private enterprises.

As a result, these elements lack an Environmental Impact Assessment framework and, consequently, the management along their life cycle is far from satisfactory. In fact, there is no examination of alternatives, the impact analysis is very weak and does not exert any influence on the projects, the mitigation is deeply cost-limited and barely effective, decision-making is guided only by administrative requirements and there is a definite absence of impacts follow-up.

5 Conclusions

Considering the current decision making framework applied by the managers of Brazilian cities, and the prevalence of economic/political interests, the present paper proposes, from the Environmental Agencies point of view, that the cities could be managed as enterprises. Their activities must receive the same approach that is applied to any enterprise in a project-EIA, establishing a set of requirements to be achieved by the projects, in terms of their environmental performance and taking into account legal and social requirements.

The EIA system in Brazil (and related Environmental Licensing) does not guarantee, in itself, an appropriate environmental performance related to urban equipments, considering the generalized level of impacts observed in socioeconomic, physical and biotic resources. However, when obeying the law, it could be a good start inducing the managers of the cities to consider some environmental requirements in their development projects.

There is a need to improve the practice of environmental management of cities, and the framework given by EIA procedures shows to be particularly attractive, considering the monitoring problems faced in developing countries. The project-EIA approach calls for the establishment, by the decision-makers, of a set of objectives and targets coupled to their organization's environmental performance (in this case, the city itself).

Thereafter, based on identification of significant environmental impacts associated with urban equipment and activities, the decision making stage would bring the terms and conditions to be observed at the implementation stage of a development project. This means the environmental performance requirements and the procedures for systematic monitoring of the impacts along their life cycle.

Playing an important role in this approach, mechanisms for public participation must be strengthened in order to bring to decision making within an EIA context an adequate balance among the stakeholder’s interests. As a consequence, this arrangement stimulates mutual – between society and local authorities – influence and accountability.

This approach could stimulate the adoption of other environmental planning tools, such as strategic environmental and sustainability assessments, hence introducing environmental issues in the early decisions.

The decision making process will be better if democracy principles can be applied to the environmental planning, in order to consider the “same” law and requirements for all types of investments (public and private ones) and to really guarantee the stakeholders’ participation instead of only a few interests deciding the outcome.

References

Ahmad, B; Wood, C (2002) A comparative evaluation of the EIA systems in Egypt, Turkey and Tunisia. "Environmental Impact Assessment Review", 22: 213-234.

Barker, A; Wood, C (1999) An evaluation of EIA system performance in eight EU countries. "Environmental Impact Assessment Review", 19: 387-404.

Bell, S; Morse, S (2008) “Sustainability indicators: measuring the immeasurable?” Earthscan, 2nd. Edition.

Bellia, V (1996) "Introdução à economia do meio ambiente". Brasília: Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis.

Brand, P; Thomas, M J (2005) "Urban Environmentalism". Routledge.

Canter, L W (1996) "Environmental Impact Assessment". 2nd Edition. New York: McGraw-Hill.

Characklis, G W; Wiesner, M R (1997) Particles, metals and water quality in runoff from large urban watershed. "Journal of Environmental Engineering", vol. 123, 8: 753-759.

Christensen P, Kørnøv L, Nielsen EH (2005) EIA as regulation: does it work? "Journal of Environmental Planning and Management", 48: 393–412.

Foladori, G (2001) "Limites do desenvolvimento sustentável". Campinas: Ed. UNICAMP.

Gibson, R B et al (2005) "Sustainability Assessment: criteria and process". Earthscan.

Giddens, A (2001) "Sociology". 4th edition. Oxford: Blackwell.

Glasson, J; Therivel, R; Chadwick, A (2005) "Introduction to Environmental Impact Assessment". 3rd. Edition. New York: Routledge.

Hall, P (1992) "Urban and regional planning". Routledge. 3rd. edition.

Jay, S; Jones, C; Slinn, P; Wood, C (2007) Environmental Impact Assessment: retrospect and prospect. "Environmental Impact Assessment Review", 27: 287-300.

Jones, C et al (2005) "Strategic Environmental Assessment and land use planning: an international evaluation". Earthscan.

Luria, P; Aspinall, P A (2003) Evaluating a multi-criteria model for hazard assessment in urban design. The Porto Marghera case study. "Environmental Impact Assessment Review", 23: 625-653.

Mendonça, F (2004) Sistema Ambiental Urbano: uma abordagem dos problemas socioambientais da cidade. In: Mendonça, F (org.). "Impactos socioambientais urbanos". Curitiba: Ed. UFPR, págs. 185-207.

Morris, P; Therivel, R (eds.) (2001) "Methods of Environmental Impact Assessment". 2nd. Edition. New York: Spon Press.

Odum, E (1988) "Ecologia". Rio de Janeiro: Editora Guanabara.

Pauleit, S; Duhme, F (2000) Assessing the environmental performance of land cover types for urban planning. "Landscape and Urban Planning", 52: 1-20.

Polèse, M; Stren, R (2000) "The social sustainability of cities". University of Toronto Press.

Rydin, Y (2003) "Urban and environmental planning in the UK". Palgrave Macmillan. 2nd. Edition.

Sánchez, L E (2006) "Avaliação de impacto ambiental: conceitos e métodos". São Paulo: Editora Oficina de Textos.

Souza, M L (2004) "Mudar a cidade – uma introdução crítica ao planejamento e à gestão urbanos". 3ª. edição. Rio de Janeiro: Editora Bertrand Brasil.

Sullivan, W C; Anderson, O M; Lovell, S T (2004) Agricultural buffers at the rural–urban fringe: an examination of approval by farmers, residents, and academics in the Midwestern United States. "Landscape and Urban Planning", 69: 299-313.

Sutherland, R A; Tolosa, C A (2000) Multi-element analysis of road-deposited in an urban drainage basin, Honolulu, Hawaii. "Environmental Pollution", 110: 483-495.

Wood, C (2000) Screening and scoping. In: Lee N, George C, editors. "Environmental assessment in developing and transitional countries". Chichester: Wiley, pp. 71– 84.

Wood, C (2003) "Environmental impact assessment: a comparative review". Second ed. Harlow: Prentice Hall.

Zandbergen, P A (1998) Urban watershed ecological risk assessment using GIS: a case study of the Brunette River watershed in British Columbia, Canada. "Journal of Hazardous Materials", 61: 163-173.

Zannin, P H T; Calixto, A; Diniz, F B; Ferreira, J A C (2003) A survey of urban noise annoyance in a large Brazilian city: the importance of a subjective analysis in conjunction with an objective analysis. "Environmental Impact Assessment Review", 23: 245-255.

Zetter, R and White, R (eds.) (2002) "Planning cities: sustainability and growth in the developing world". ITDG Press.

Interdisciplinary suitability analysis of prospective areas for low-rise housing in Tyumen suburbs (Tyumen region, Russia)

Nelya Rakhimova

Tyumen State University, Russia

It is increasingly recognized that in the second part of twentieth century the acceleration of urban population growth, city development, urban sprawl, and megalopolises leads to the spreading of urban life-styles to rural areas or the movement of urban populations to suburban areas, i.e. suburbanization. Suburbanization of big cities is a diffusion process when present communications, transport accessibility and the mobility of the population influence the placement of various objects. That is, the presence of existing infrastructure plays a large part in determining the placement of various objects. Nevertheless, we should pay more attention to other factors.

Post-perestroika Russia too experienced the effects of suburbanization. The initial boom in country house building involved the central regions of Russia. Later this process became more popular not only in the European part of country but in peripheral regions as well. Tyumen region is one of them. However, it was only in recent years that real legislation regulating land use in suburbs came into force. In response to the growing demand for out-of-town housing, the city administration made a decision to assign relevant areas for low-rise housing.

This paper is devoted to developing housing in Tyumen suburbs which means that the considered activity is housing construction. Therefore, it is necessary to combine relevant factors that I need to consider for this kind of activity which could play a key role in the area's development. There are two areas for consideration: compliance with the requirements of construction and the comfort of prospective living. Based on these and existing information I can define four basic directions for assessment: landscape-ecological assessment, ecological state assessment, aesthetic qualities assessment and transport accessibility assessment.

Taking into account all these factors, I hope to prove that the assessment is sufficiently complete even it is a subjective expert's assessment. It is a two-part process. The first stage is a comparative assessment, using a values-based analysis for each area. The second stage is to use the sum of the comparative indices generated by the first stage to determine the area most suitable for development.

The total comparative assessment of areas for prospective low-rise housing is the resulting total of all undertaken assessments where favorable factors have a positive value of points and where unfavorable factors, such as ecological pollution, have a negative value.

Accordingly, based on the General Tyumen layout I have picked out five prospective areas for low-rise housing. The results show us that area 4 (Moskovskii-Ozhogino) has the best features for low-rise housing.

In conclusion, different level plans with suitability analysis approaches like this can form one of the axes of a sustainable development strategy, both for individual districts as well as for the country as a whole over the long-term period. My research is just one of the attempts to apply the suitability analysis to a real Russian city where there are challenges about developing low-rise housing in order to create a sustainable interconnected natural and man-made system for comfortable living.

Keywords: assessment methods, housing, integrated sustainability assessment, sustainable development, comparative urban sustainability

1 Introduction

It is increasingly recognized that in the second part of twentieth century the acceleration of urban population growth, city development, urban sprawl, and megalopolises leads to the spreading of urban life-styles to rural areas or the movement of urban populations to suburban areas, i.e. suburbanization. Suburbs first appeared in the big cities of the USA from the end of nineteenth to the beginning of twentieth century (Varivonchik 2004). The reason for this was the arrival of new types of transportation like automobiles and electric trains. This phenomenon then spread to Europe, at first to the west and then to the east. It was associated with the advantages of having a privately-owned home, independence and a high standard of living. Post-perestroika Russia too experienced the effects of suburbanization. The initial boom in country house building involved the central regions of Russia. Later this process became more popular not only in the European part of country but in peripheral regions as well.

There are several stages to suburbanization: the selection of lands, the construction of surface facilities and direct construction, the utilization of the constructions according to their intended purpose and the maintenance of sustainability. However, the first step defines further development so the selection of lands is a fundamental step. In order to furnish it with the relevant characteristics of the prospective areas, it is necessary to introduce the following interdisciplinary suitability analysis of Tyumen's suburbs.

2 Tyumen General Layout and Suburbanization

Tyumen city is one of the biggest modern cities in Siberia, and suburbanization is one of the typical processes in developing Russian cities. However, it was only in recent years that real legislation regulating land use in suburbs came into force. In response to the growing demand for out-of-town housing, the city administration made a decision to assign relevant areas for low-rise housing.

Now planning aspects are regulated by the Architectural Code of the Russian Federation, and issues of suburban planning fall within the purview of regional planning. So far there is not enough attention to all necessary aspects in these official documents.

Tyumen's general layout was passed in Tyumen in May, 30, 2006, after being generated by "Russian research institute Urbanistika" (St. Petersburg). This document is a basic document that assigns fundamental points of special and infrastructural development of the city.

On its basis the complex of the plans and legal documentation adjusting both town-planning activity and providing sustainable development of territory of the city is developed. New borders of the city district, which essentially differ from the old border of the city have been ratified. (see Figure 1) Therefore, the territory separated by the border of the city district and not entering into a city area can be considered as suburban territories. According to the general plan, by 2015, in Tyumen there should live about 650 thousand people, and by 2040 - up to 1 million (official data).

Areas for individual housing development were defined in suburban territories. Low-rise individual housing will be built there; indeed, in some areas the construction is already in process. Nevertheless, what follows is an integrated study of the prospective areas according to their suitability for this kind of construction. In this case, it is more reasonable to compare all the areas.

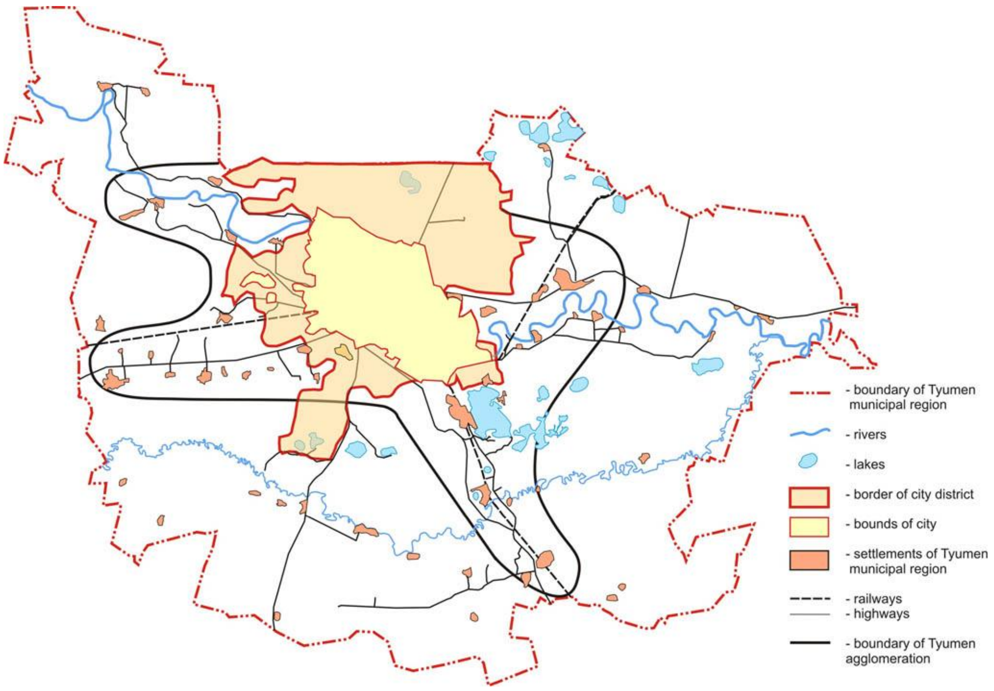


Figure 1: Localization of city district in boundaries of Tyumen agglomeration

Accordingly, based on the General Tyumen layout five prospective areas have been selected for low-rise housing (see Table 1, Figure 2).

Table 1: Areas of low-rise suburban housing according General Tyumen layout

№	Main direction of territorial development	Accepted name for convenience	Square, km^2
1	Northern-west	Kazarovo - Bereznyaki	22,9
2	Northern-east	Matmasy	8,2
3	West	Voronino - Plehanova	19,13
4	South	Moskovskii - Ozhogino	24,73
5	East	Lesobaza	1,13

3 Interdisciplinary suitability analysis

Suburbanization of big cities is a diffusion process when present communications, transport accessibility and the mobility of the population influence the placement of various objects (Antrop 2000: 257-270). That is, the presence of existing infrastructure plays a large part in determining the placement of various objects. Nevertheless, more attention should be payid to other factors.

The primary consideration for any development should be its fitness for purpose, i.e. how comfortable, convenient and aesthetically pleasing it is for the people who will live there. Unlike in developed countries, debates about the use of suitability analysis approaches in planning procedures are not seen as germane to this process in Russia. Nevertheless, in this research some existing approaches of landscape ecology to Tyumen have been applied.

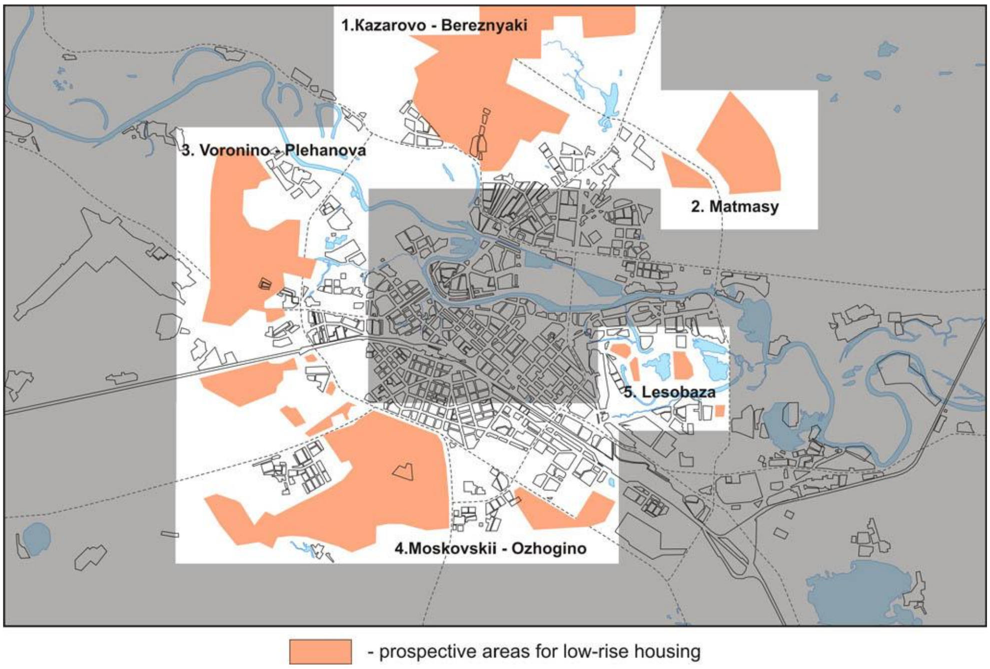


Figure 2: Localization of areas of low-rise suburban housing according to General Tyumen layout

Suitability analysis of the landscapes - as prominently advanced by McHarg (1969) and others – has over the last thirty years become accepted as one of the most comprehensible and defensible approaches to landscape planning. Its basic purpose is to determinate the appropriateness of a given landscape for a particular use. The basic premise of suitability analysis is that each aspect of the landscape has intrinsic characteristics that are in some degree either suitable or unsuitable for the activities being planned, and that these relationships can be revealed through detailed evaluation and assessment (Marsh 1998). Such suitability is determined through systematic, multi-factor analysis of the different conditions of the landscape. Ideally, the result is a site arrangement that takes advantage of the landscape's intrinsic attributes while avoiding unsuitable or unsupportable locations for activities where obvious site conflicts or incompatibilities may be expected. The intention of the process is to determine the optimum site location for activities while minimizing negative impacts on the environment (Murphy 2005).

The factors to be considered in suitability assessment include the human, biotic and abiotic aspects of the landscape. Human factors include community need, economics, community organization, demographics, land use, and history. Biotic factors include wildlife and vegetation. Abiotic factors include soils, hydrology, topography, geology, and climate. The independent analysis of these factors is carried out to determinate the extent to which each factor is favorable or unfavorable for the location of the activities being considered and leads to a suitability assessment for each activity.

There also are a series of cultural features that typically considerations as land use, zoning, circulation, utilities, and community service facilities. The site being analyzed is mapped with different suitability assessment layer for each factor considered. For example, there might be suitability assessment for landscape layers such as topography, soils, geology, vegetation, and so on. Each layer is mapped to indicate those portions of the site that are suitable, unsuitable, or neutral for each particular activity being contemplated. The maps do not reveal the site conditions themselves, such as topography, but the extent of suitability for development as revealed by an assessment of that particular site factor. The suitability assessment may be expresses, for example, as high, moderate, or low suitability. Ultimately, all of the site factor suitability maps may be synthesized into a composite map to provide an overall picture of the site as a whole for the different land uses being considered.

The suitability analysis process provides a systematic method of assessing a wide range of site conditions and land uses. In its composite form the suitability map provides a cumulative, as well as the most problematic, array of site conditions in regard to each particular type of land use. From this comprehensive assessment, overall site organization decisions may be made on the basis of spatially specific evidence.

Although it is cumulative rather than holistic, the suitability analysis approach to making land use planning and design organization decisions has demonstrated its value. The process helps designers examine, set parameters, and solve the problems associated with locating human activities in the landscape in ways that use the resources of the landscape to optimum advantage (Ndubisi 1997: 9-39).

The housing construction in Tyumen suburbs is an object of research. Therefore, it is necessary to combine relevant factors that need to be considered for this kind of activity which could play a key role in the area's development. There are two areas for consideration: compliance with the requirements of construction and the comfort of prospective living. Based on these and existing information four basic directions for assessment can be defined:

- Landscape-ecological assessment *
- Ecological state assessment
- Aesthetic qualities assessment
- Transport accessibility assessment

* The landscape-ecological assessment in this research is based on the following definition of landscape: it is a natural genetically homogeneous territorial complex with a unified geological structure, a certain class of relief, climate and biotic cover. This interpretation of landscape is accepted in Russian science. The method of landscape description and mapping was developed by Professor Kozin V.V.(1996: 36-48) of Tyumen State University. The presented landscape-ecological assessment is an integrated assessment of natural conditions including geology, relief, soil, hydrological, and vegetable features of the areas.

Taking into account all these factors, the assessment should be sufficiently complete even it is a subjective expert's assessment. It is a two-part process. The first stage is a comparative assessment, using a values-based analysis for each area. The second stage is to use the sum of the comparative indices generated by the first stage to determine the area most suitable for development.

3.1 Landscape-ecological assessment

Modern architectural activity should be based on an area's natural features, and directed to safeguarding favorable conditions of living, including the regulation of rational environmental management and protection of the environment. Simultaneously, attention should be paid to the issue of sustainable development, both for settlements and for the countryside between these settlements, including the limitation of the harmful influence of economic and other activities to the environment and its usage by the present inhabitants without compromising the ability of future generations (Architectural Code of the Russian Federation, 2004).

In Russia, the main challenge of planning procedure is to estimate present natural conditions in terms of stability and the value of landscapes. These parameters are more important for residential area planning: stability is the ability of the landscape (landscape complex) to maintain its rate of functioning and spatial structure under changing external influences (Kurbatova 2004); and value is the aggregate of aesthetic attractiveness, uniqueness, comfort and recreational resources of the landscape (Drozdov 2006).

Therefore, the main factors of stability for housing are the engineering-geological features of an area (groundwater line, surface slope, ground structure etc.) (Gorodetskaya 1972), where value is the sum of uniqueness, comfort and the recreational potential of landscape (Vladimorov 1986).

It is necessary to define what is more important for the assessment. It is indisputable that both categories are important. However, factors of value could be created by man, whereas factors of stability would define the possibility of buildings existing at all. If there are adverse engineering-geological conditions, construction cannot be undertaken because it could lead to deplorable results in the future, even if it is a low-rise apartment building.

A matrix of value and stability parameters (see Table 2) can be constructed and an integral coefficient for the attraction (κ_i) of the developing landscape identified in order to offer a more opportune comparative assessment for further application of this data in suburban planning. For that priority has been given to stability factors using an additional coefficient 1,5.

Table 2: Matrix of integral coefficient for the attraction of the developing landscape(κ_i)

Value / **Stability**	**Highly valuable**	**Valuable**	**Not valuable**
Highly stable	7,5	6,5	5,5
Stable	6	5	4
Unstable	4,5	3,5	2,5

Having defined the integral coefficient for the attraction of each developing landscape for individual suburban housing, this formula may be used to assess the attraction of some areas comparatively taking into account the area ratio of landscape with different measures of integral coefficients for the attraction of the developing landscape:

$$K_m = \frac{\sum_1^i S_i \times \kappa_i}{S_c},$$

where K_m – average coefficient of attraction for area, κ_i – integral coefficient of attraction of particular landscape, S_i – square area of landscapes with the same value of κ_i, S_c – total square area of land under assessment.

When the average integral coefficient for each area has been determined it is easy to define the most prospective one from a landscape-ecological point of view.

A landscape map based on existing cartographical materials (topographic map 1:100000, materials of General Tyumen layout, Map of engineering-geological conditions – 2001, Atlas of Tyumen region etc.) has been composed. Having defined the integral coefficient for the attraction of each developing landscape coming into a frame of areas of interest and having done accounts with the formula mentioned above, the average integral coefficient for each area (see Table 3) have been defined. The ratio between landscapes with different measures of stability and value can be seen in the diagram (see Figure 3)

Table 3: Average integral coefficient for the attraction of areas

№	**Accepted name for convenience**	**Square, sq. km**	K_m
1	Kazarovo - Bereznyaki	22,9	4,4
2	Matmasy	8,2	4,6
3	Voronino - Plehanova	19,13	5,7
4	Moskovskii - Ozhogino	24,73	6,1
5	Lesobaza	1,13	4,3

As can be seen in the table 3, areas 3 (Voronino-Plehanova) and 4 (Moskovskii-Ozhogino) are more attractive for development from the landscape-ecological point of view. It is because these areas are located on an lacustrine-alluvial plain that is more favourable for housing. Moreover, there are certain landscapes which have the best measure of value for this kind of activity - deciduous and mixed forests.

The rest of areas are located in less stable natural complexes, where the groundwater line can reach 0,2–0,5 meters from a surface that is very unfavorably for construction. Moreover, a major part of these lands is occupied with open channel drainage or swampy lands, some areas are covered with ash dumps from an old thermal power plant that had been burning peat. In order to develop the necessary conditions in these areas it is indispensable to undertake regenerative actions that could entail additional costs from a developer.

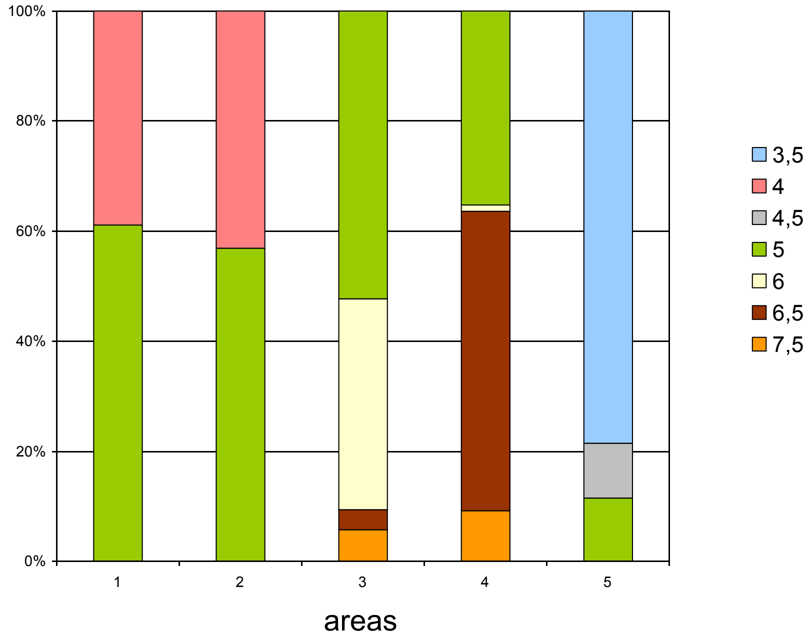


Figure 3: Percentage ratio between landscapes with the same integral coefficient of the attraction of the developing for areas of the interests

3.2 Ecological state assessment

According to the law of environmental protection (Federal law of environmental protection, 2002), ecological factors are crucial while making decisions about new construction activity, reconstruction and extension. Therefore, it is necessary to take into account the ecological state of the areas during the integrated assessment.

Five key categories of ecological conditions were selected: air, noise, radiation, electromagnetic pollution, and the presence of city dumps. As it is a point-assessment, the highest level of negative conditions gives the highest points (3) and vice-versa (0). It is necessary to mention that the most important factor is air pollution because Tyumen is the type of city where the level of anthropogenic load is determined mostly by air pollutants, while more than 80% of air pollution in Tyumen is emitted by vehicles. Noise pollution is influenced by two airports (local and international) and vehicles as well. The presence of electromagnetic fields is caused by power transmission lines that cross some prospective areas.

In order to define the level of pollution, data from Tyumen ecological committee, materials from General Tyumen layout, and library material were used. The maps of ecological factors were created on the basis of all this information (see Figures 3 and 4). The results of ecological state assessment are presented in table 4.

As can be seen from the table 4 area 1 (Kazarovo - Bereznyaki) is the most ecologically unfavorable territory and it is not just because of air pollution. There is also quite a high level of noise and radiation pollution. Area 5 (Lesobaza) is the most polluted with air emissions because there are industrial pollution sources and storage rooms, highways for freight transportation. Also there are ash dumps from an old thermal power plant that had been burning peat. Areas 2 and 4 have the most favorable ecological state.

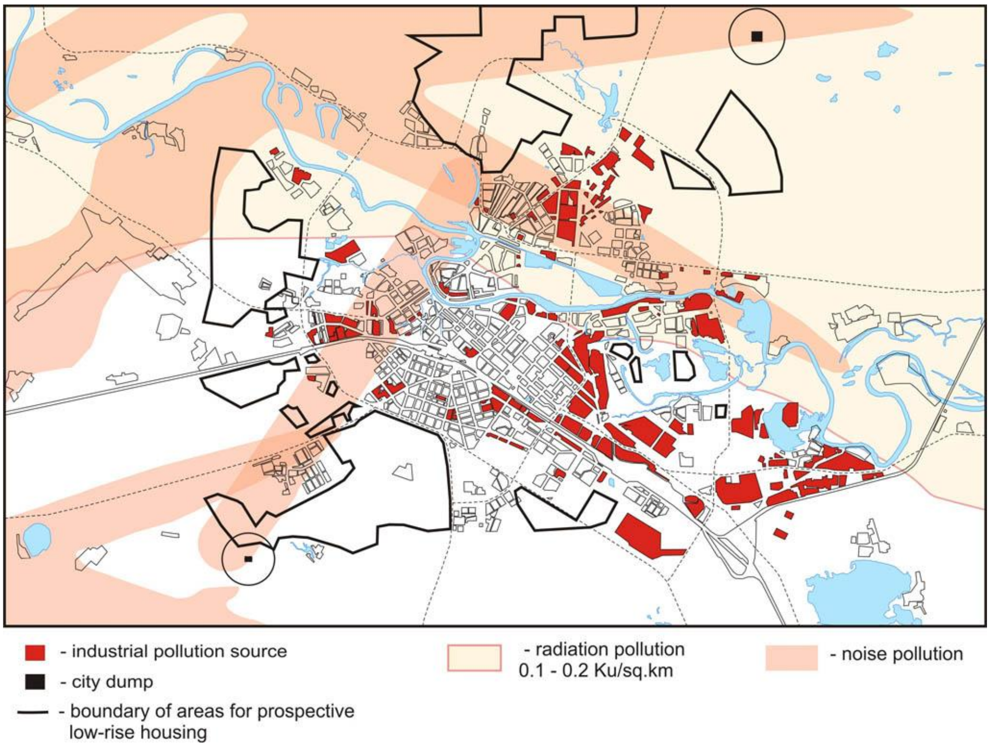


Figure 4: Noise and radiation pollution, and city dumps in the areas of interest

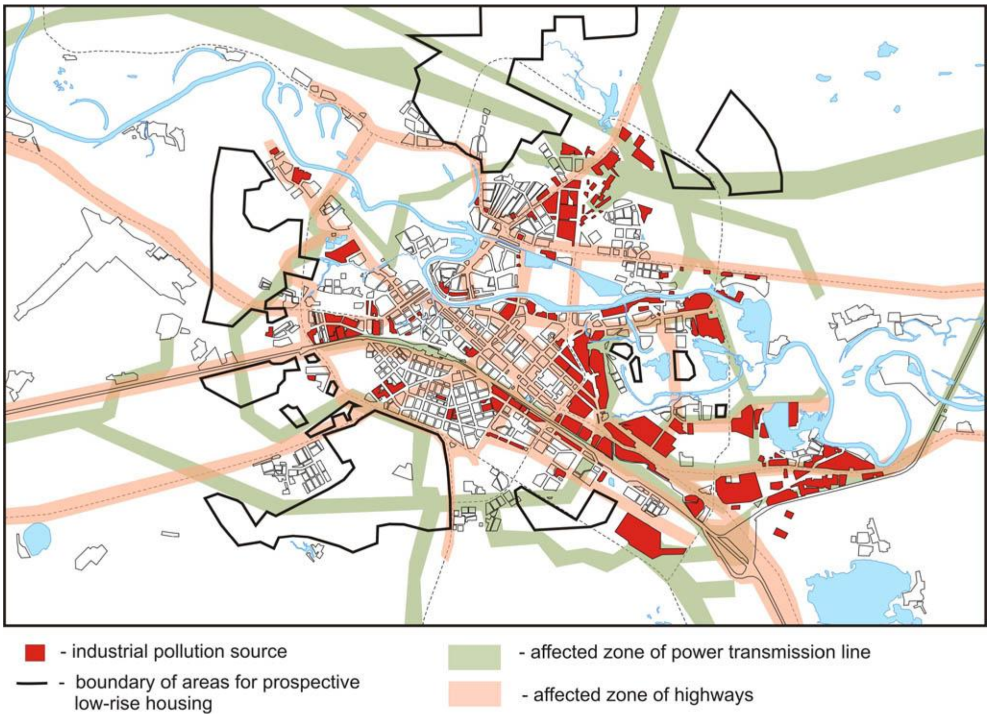


Figure 5: Affected areas of power transmission lines and highways

Table 4: Results of ecological state assessment in points

Key categories of ecological state	**Areas, points**				
	1	**2**	**3**	**4**	**5**
Air pollution	2	1	2	2	3
Noise pollution	2	0	1	0	1
Radiation pollution	2	2	2	0	0
Electromagnetic pollution	1	1	1	1	0
City dumps	0	0	0	1	1
Total	**7**	**4**	**6**	**4**	**5**

3.3 Aesthetic qualities assessment

Measuring artistic richness is quite subjective, and it is extremely difficult to measure attractiveness with a few simple and exact criteria. How, then, is it possible to approximately measure feeling when a view is seen?

Natural aesthetic resources is the whole environment surrounding people that excites them with aesthetic satisfaction. This definition was given by K.Ėringis and A.R.Budriūnas (2000). The first ratings of landscape aesthetic resources were carried out by K.Ėringis and A.R.Budriūnas in 1962. In 1968 their works were generalized in the first map of aesthetic resources of the Lithuanian landscape and in 1970 a Method for Aesthetic and Ecological Assessment of Landscape was published. The method is based on a complex assessment of basic elements of landscape. Any elements of scenery are indicators of aesthetic quality. The indicator can have a positive or negative value.

The assessment has been improved for the purpose of conformity with the area of interest and now it is an integrated assessment of aesthetic qualities.

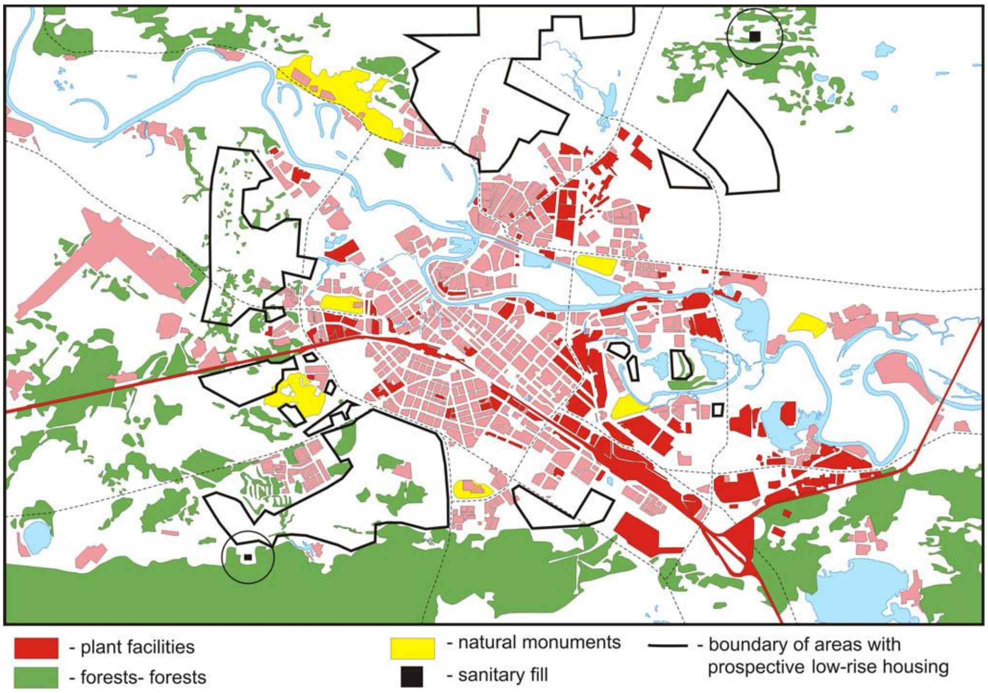


Figure 6: Aesthetic quality factors in the areas of interests

The assessment has been made based on a map of factors that can influence people’s perception (see Figure 6). This map has been created by combining different cartographical and photographic materials. The results of the point assessment are presented in Table 5.

The relief is flat everywhere, and there are not many ponds except area 5 (Lesobaza). Here some artificial ponds and some former riverbeds of the Tura River can be found. The abundance of green areas and forests is also different. Areas located in the north of the city do not have a lot of picturesque vegetation; on the contrary, swampy territory is spread there. There are no historical and natural monuments either. Next to areas 1, 2, 3 and 4 there are some comparatively small local natural sights and natural monuments. All areas are located next to industrial zones in the city which are a negative factor for aesthetic quality. As can be seen from the table 5, area 3 (Voronino-Plehanova) has the best aesthetic qualities.

Table 5: Results of aesthetic qualities assessment in points

Key categories of ecological state	**Areas, points**				
	1	**2**	**3**	**4**	**5**
Attractiveness of relief	0	1	1	1	1
Plenty of ponds and lakes	1	0	1	0	2
Plenty of forests	1	0	2	2	1
Presence of historical and natural	1	0	1	1	1
Presence of industrial objects	-1	-1	-2	-2	-3
Total	**2**	**0**	**3**	**2**	**2**

3.4 Transport accessibility assessment

Transport accessibility is very important for prospective owners of houses in the suburbs. The linear structure of Tyumen, the underdevelopment of transverse direction, the unsystematic solutions to transport problems, and the artificial and natural barriers lead to a situation where the main traffic artery under existing conditions of high level of automobilization does not suit the modern needs of the population. The average speed of cars in rush hour does not exceed 14 km per hour (Guseinov 2001).

In order to make a transport accessibility assessment, the methodology used was developed by the construction company “Terra-Nedvizhimost” while building a suburb of Moscow (www.terra.ru). It is common to estimate transport accessibility by path length, although the time of the path is more important for modern citizens. Therefore, the time to reach the city centre from the suburbs in rush hour is defined as a criterion. Only the time required for driving through the main highways was measured. The General Post Office was selected as the city centre. There are three zones of different transport accessibility according to expended time:

- comfort zone – under 30 min
- acceptable zone – from 30 min to 1 hour
- unacceptable zone – more than 1 hour

As the average speed of cars in rush hour is about 14 km per hour, the average driving time for the main highways leading to the city centre that are defined in the General Tyumen layout as highways of uninterrupted driving has been calculated. (see Table 6)

Therefore, according to the results of the calculation, it can be seen that no one area is in the comfort zone. However, as a map of transport accessibility has been composed (see Figure 7.) as was recommended in the methodology, it is easy to see that part of area 4 is in the comfort zone. Consequently, this area is admitted as a comfort zone. Areas 3 and 5 are in the acceptable zone, but 1 and 2 are unacceptable because it takes more than 1 hour to get to the city centre from these areas. Moreover, in these areas many of the roads are under construction now which could create difficulties when getting to any region of the city.

Table 6. Results of transport accessibility assessment

№	Accepted name for convenience	Average length, km	Time, hours	Points
1	Kazarovo – Bereznyaki	18,5	1,27	0
2	Matmasy	16	1,10	0
3	Voronino – Plehanova	11,4	0,79	1
4	Moskovskii – Ozhogino	10,2	0,70	2
5	Lesobaza	11,6	0,80	1

3.5 Total comparative assessment of areas for prospective low-rise housing in Tyumen's suburbs

The total comparative assessment of areas for prospective low-rise housing is the resulting total of all undertaken assessments where favorable factors have a positive value of points and where unfavorable factors, such as ecological pollution, have a negative value. All results are in the table 7.

The results demonstrate that area 4 has the best features for low-rise housing. This has the most stable natural complexes (landscapes), the ecological state is acceptable and it is within the comfort zone of transport accessibility.

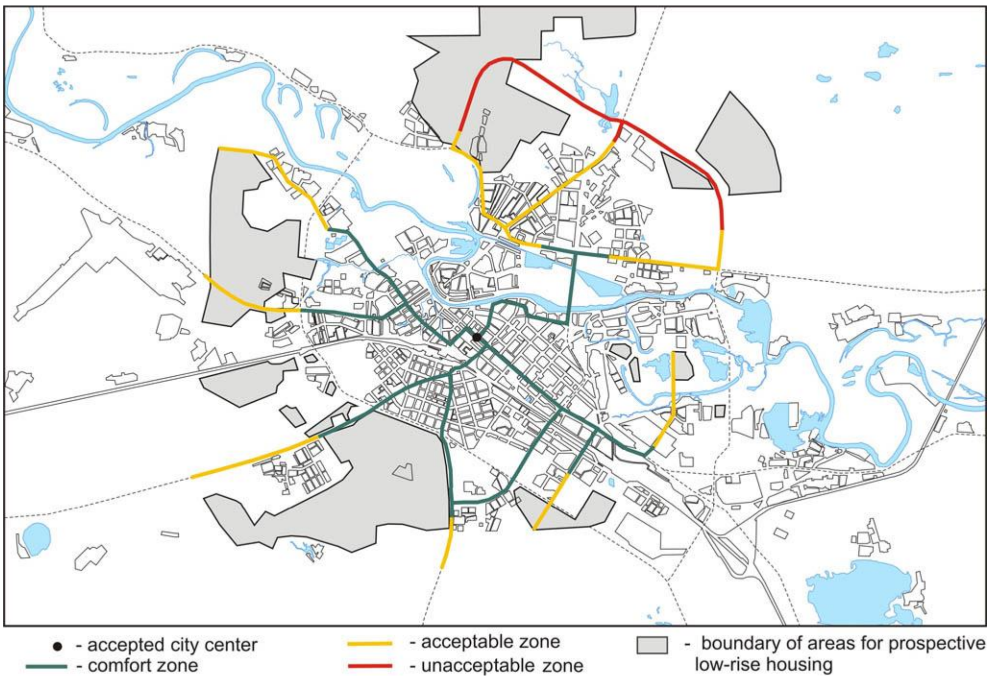


Figure 7: Map of transport accessibility zones

Table 7: Results of total comparative assessment of areas for prospective low-rise housing

Undertaken assessments	Areas, points				
	1	2	3	4	5
Landscape-ecological assessment	4,4	4,6	5,7	6,1	4,3
Aesthetic qualities assessment	2	0	3	2	2
Ecological state assessment	-7	-4	-6	-4	-5
Transport accessibility assessment	0	0	1	2	1
Total	**-0,6**	**0,6**	**3,7**	**6,1**	**1,3**

Area 3 is also quite favorable territory for low-rise housing. This also has stable landscapes, and, moreover, it has the most attractive view, but the ecological state is unfavorable. Although area 5 has acceptable transport accessibility and high aesthetic qualities (there are some ponds and forests), it is located on a flood plain of the Tura river which means that landscapes here are not really stable for construction over the long term. Areas 1 and 2 according to this assessment are unfavorable for low-rise housing.

4 Conclusion

A complex comparative suitability assessment of areas for prospective low-rise housing has been undertaken taking into account different factors. There is no doubt that it is necessary to undertake some improvements in areas that were defined as unfavorable that could entail additional costs for a developer. Prospective developers should cultivate the landscape and maintain it in an acceptable condition for housing. It is necessary to minimize ecological degradation from different sources and not allow its growth in the future. Green areas are also an important factor for ecological and aesthetic conditions. Currently, the number of parks is unacceptable so prospective developers should pay more attention to the development and maintenance of green areas. The transportation system needs to be re-thought, as the existing transport arteries can not accept the predicted transport load.

In conclusion, different level plans with suitability analysis approaches like this can form one of the axes of a sustainable development strategy, both for individual districts as well as for the country as a whole over the long-term period. This research is just one of the attempts to apply the suitability analysis to a real Russian city where there are challenges about developing low-rise housing in order to create a sustainable interconnected natural and man-made system for comfortable living.

5 References

Antrop, M (2000) Changing patterns in the urbanized countryside of Western Europe, 'Landscape Ecology' volume 5, p.257-270.

Drozdov, A V (2006) "Landscape planning with engineering biology elements". Moscow: Association for scientific publications.

Ėringis K, Budriūnas A (2000) "Methodology for the. evaluation of landscape esthetical recreation". Vilnius: Institute of Botany.

Gorodetskaya M E (1972) "Morphostructure and morphosculpture of the south of Western Siberian plain", Moscow: Nauka.

Guseinov A N (2001) "Ecology of Tyumen city: conditions and issues". Tyumen.

Kozin V V (1996) Issue of landscapes value and stability. 'Environmental management in northern-west of Siberia', 36-48.

Kurbatova D S (2004) "Landscape ecological basis of town planning structures forming". Moscow-Smolensk: Madzhenta.

McHarg I (1969) "Design with Nature", Garden City, N.Y.: Natural History Press.

Murphy M (2005) "Landscape Architecture Theory: An Evolving Body of Thought". Long Grove, Illinois: Waveland Press.

Ndubisi F (1997) Landscape Ecological Planning, in G Thompson and F Steiner, eds., 'Ecological Planning and Design', 9-39.

Varivonchnik I V (2004). Country of suburbs: American dream today. 'USA – Canada. Economics, politics, culture' volume 7, 72-85.

Vladimorov V (1986) "City and landscape", Moscow: Nauka.

William M (1998) "Landscape Planning: Environmental Applications", Third Edition.

Assessment of thermal comfort inside primary governmental classrooms in hot-dry climates Part I – a case study from Egypt

Tamer Gado[1], Mady Mohamed[2]

1 – University of Dundee, UK
2 – Zagazig University, Egypt

The provision of primary schools in Egypt is one of the demanding issues facing the government since the earthquake of 1992. In the aftermath of the quake, the government has built a substantial number of primary schools around the country in an attempt to replace schools lost in the disaster. This work aims to investigate the environmental performance of governmental primary schools in Egypt as an example of a hot-dry climate. The study is presented in two parts. In this paper the results of the subjective assessment of the case studies is discussed. Work was done on three stages; the first and the second investigated the environmental problems inside 19 case studies in al-Minya Governorate. The third stage further investigated the thermal comfort of occupants inside three case studies. The results suggested that the majority of the occupants were thermally discomfort for most of the time during the academic year. In the second part, the results of a field study aiming to objectively assess the thermal performance of a small sample of classrooms were discussed. This study will inform future work investigating the potential of passively enhancing the thermal comfort of occupants inside primary governmental classrooms in Egypt.

Keywords: assessment, building, environmental assessment

1. Introduction

Schools can act as regeneration catalysts by contributing to the development of the area around them. This was evident through the project of the 100 schools initiated by the Government in some areas of Greater Cairo, where the school buildings were refurbished and were opened to the community boosting by such the sense of pride of both the children and the society.

Internal environmental quality (IEQ) of schools can significantly affect the occupant's perception of space as well as their health, performance, physical comfort and mental wellbeing. Unhealthy classrooms with poor IEQ, including thermal performance, are known to cause absenteeism among staff and pupils, and negatively affect the performance of children. Children are at particular risk since they are more susceptible than adults to the effects of poor air quality, which can be "subtle and do not always produce easily recognisable impacts on health and wellbeing" (Lee & Chang, 2000). Moderate heat stress can affect children's mental performance. This was suggested when a sample of young people's mental performance was significantly affected by the slight temperature increase of only a very few degrees within the range likely to be found in a typical classroom (Wyon et al. 1979).

A child inside a classroom collects the majority of information about their surroundings through their auditory and visual systems. The later is stimulated by light reflected off surrounding surfaces. The quantity of light affects the child's nervous system and neuroendocrine hormonal system (Edwards and Torcellini 2002) while the quality will profoundly affect the children psychologically and physiologically. Poor acoustic performance of classroom affects the occupants and increases the strain on the teachers' voice (Stansfeld and Haines 2002). Children in primary classrooms are particularly vulnerable to noise effects because it can interfere with the learning process during a critical developmental period. Children exposed to noise in schools showed "deficits in sustained attention, visual attention, concentration, poorer auditory discrimination and speech perception, memory impairment and poor reading ability and (decreased) school performance" (Stansfeld and Haines 2002).

2. Previous work

Previous work conducted across several countries in the area of schools' internal air quality (IAQ) found that most of the case studies were inadequately ventilated and were high energy consumers. In the UK, the Building Research Establishment (BRE) in an attempt to assess the performance of the current stock of new school buildings monitored the ventilation and indoor air quality inside a representative sample of primary schools in England (BRE 2003). Results showed that 50% of the measurements were under the minimum rate required by the British Standards. Another study looked into the recommended suitable ventilation rates for classrooms and examined the suitability of the air quality guidelines for classrooms (Clements-Croome et al. 2005). A recent comprehensive study in the UK found that the attention of children inside a poorly ventilated school was significantly slow (Clements-Croome et al. 2008). Other studies (Cook 1990; Galasiu and Veitch 2006; Stewart 1981) looked into the behaviour and attitudes of children towards the visual environment of classrooms and the effect of artificial lighting on energy consumption. They found that many primary classrooms in the UK and abroad fail to meet the minimum requirements of the illuminance and glare protection recommendations given by different lighting codes.

Studies that looked solely into the thermal performance of classrooms (Corgnati et al. 2007; Kwok and Chun 2003; Lin et al. 2005) showed that the occupants of the majority of cases were not thermally comfortable most of the time. Only few studies (Becker et al. 2007; Gado et al. 2005; Kruger and Zannin 2004; Wong and Jan 2003) looked into a combination of more than one environmental factor.

Previous work in general is limited to cold and temperate climates. Knowledge about the environmental performance of schools in hot-dry climates is very limited. In Egypt, the majority of the researches approached school design from social, educational, economical or theoretical points of view and very few looked into their environmental design. Toulan focused on the conceptual design of primary schools (Toulan 1982). Abdalla studied the impact of new educational tools on both conceptual design and human dimensions in schools (Abdalla 1994). Others studies (El-Mola 1999; Shalabi 1996) investigated different ways of architecturally responding to the educational process. El-Nashar studied the physical setup of the educational spaces and its impact on children's behaviour (El-Nashar 1998). Noufal studied factors affecting schools built in overcrowded districts of Cairo (Noufal 1998). El-Hefnawy investigated health and safety issues in educational buildings and especially in primary and preparatory schools (El-Hefnawy 2002). The Housing Building and Urban Planning Research Centre conducted a research aiming to formulate guidelines for designing fundamental schools in Egypt (Housing Building and Urban Planning Research Centre HBURC 1987). This study looked into the quality of educational spaces, their occupants' responses and their environmental performance. The most recent research was conducted by the Institute of Environmental Studies and Research (Institute of Environmental Researches and Studies (IERS) 1992) investigating the conceptual design of schools, landscape, materiality, and solar shading but failed to investigate their environmental performance.

It is clear that only few studies have touched on the environmental performance of primary schools in Egypt. The majority of work has been oriented towards other aspects of primary school design. This gap in the body of knowledge was identified and is being approached in this research project.

3.Research background and problem

The demand for primary schools in Egypt is one of the stressing issues facing the Egyptian Government since the earthquake of 1992. This demand had considerably doubled during the last fifty years when the 1952 Revolution provided the members of all sectors of the community with free education and abolished fees for public schools. The Ministry of Education's budget was doubled in one decade and the expenditures on school construction increased by 1000% between 1952 and 1976 (Metz 1990). Providing free education to children from all social sectors dramatically increased the demand for educational infrastructure including school buildings. In the early 1990s the Egyptian Ministry of Education increased the number of primary school years from 5 to 6 and subsequently the demand increased again (Gado et al. 2005). This demand had also substantially increased after the 1992 earthquake that hit Egypt with a magnitude of 4.7 on the Richter scale (Farag 2002). The tremor affected 3964 buildings including a considerable number of schools. In response, the Egyptian Government established the General Authority of Educational Buildings (GAEB) to design new schools around the country.

GAEB uses the same prototypical designs to build schools across the different climatic design regions of Egypt without any consideration to the variation in climatic conditions (Figure 1-A).

All prototypes are designed in cellular fashion using standardized structure and construction systems on a very low budget. By the mid 1970s the “public investment in new educational infrastructure has declined in relation to total educational expenditures; about 85 percent of the Ministry of Education's budget has been designated for salaries” (Metz 1990).

Although this approach could have allowed rapid build, the new classrooms are rigid and uncomfortable. Previous work (Gado et al. 2005) suggested that the internal environmental quality of classrooms in new Governmental schools in Egypt is very low. This can prove damaging and can bread resentment for the space. The design hinders the activities occurring within, and do not respond to the changing needs of primary education imposed by the Government new reforms. Classrooms are arranged along long corridors in an age hierarchy with no common spaces or activity halls. Bad primary school design is of a great concern since children in Egypt up to the age of twelve spend from around 22% of their time in mainstream schooling, with primary schools representing 44% of all pre-university education (Ministry of Education 2005).

4.Research Methodology

This work aims to investigate the environmental performance of governmental primary schools in Egypt. In this part of the paper, the subjective assessment of nineteen case studies representing the three most common prototypes used by GAEB in al-Minya and represent 80% of the primary schools built across the country (GAEB 2004). Al-Minya Governorate lies in the desert climatic design region; the largest region in Egypt (Figure 1-A). The case studies included 5 schools of the six classrooms prototype (T6) single Row Form and double Row Form, 9 schools of the twelve classroom prototype (T12) single Row Form, double Row Form and L-shape plans and 5 schools of the eighteen classrooms prototype (T18) double Row Form. The case studies are located in seven different towns of al-Minya Governorate, twelve were built in rural context and seven were built in urban context (Figure 1-B).

The field study was conducted on three stages. The first stage collected information about the environmental performance of 18 case studies. Ten factors indicating the environmental performance of school buildings were observed across the case studies. These were: the water use, energy consumption, land use, health and safety, environmental impact of materials, internal air quality, thermal performance, visual performance, noise control, space acoustics. Analysis of results indicates that all schools performed very poorly across all investigated factors. However, thermal, visual and acoustic comforts inside classrooms were found to be the major problems (Gado et al. 2005).

In the second stage, the subjective response of 108 occupants (29% were females) inside 54 classrooms were gathered during May 2005; the hottest month of the year in al-Minya during the academic session (mid September to early June). Six occupants were chosen randomly from each school, three pupils and three teachers. Observation and semi-structured interviews with closed ended and open ended questions had been employed to investigate the thermal, visual and acoustic comfort inside the classrooms. The interviews were used to collect data related to the occupants' state of comfort inside the classrooms. Interviews used open ended questions to explore the subjective response of the occupants, while closed ended questions were used to allow the application of statistical analysis on the results. Analysis of results suggested that the thermal comfort is the most critical issue across the case studies. (Gado et al. 2005).

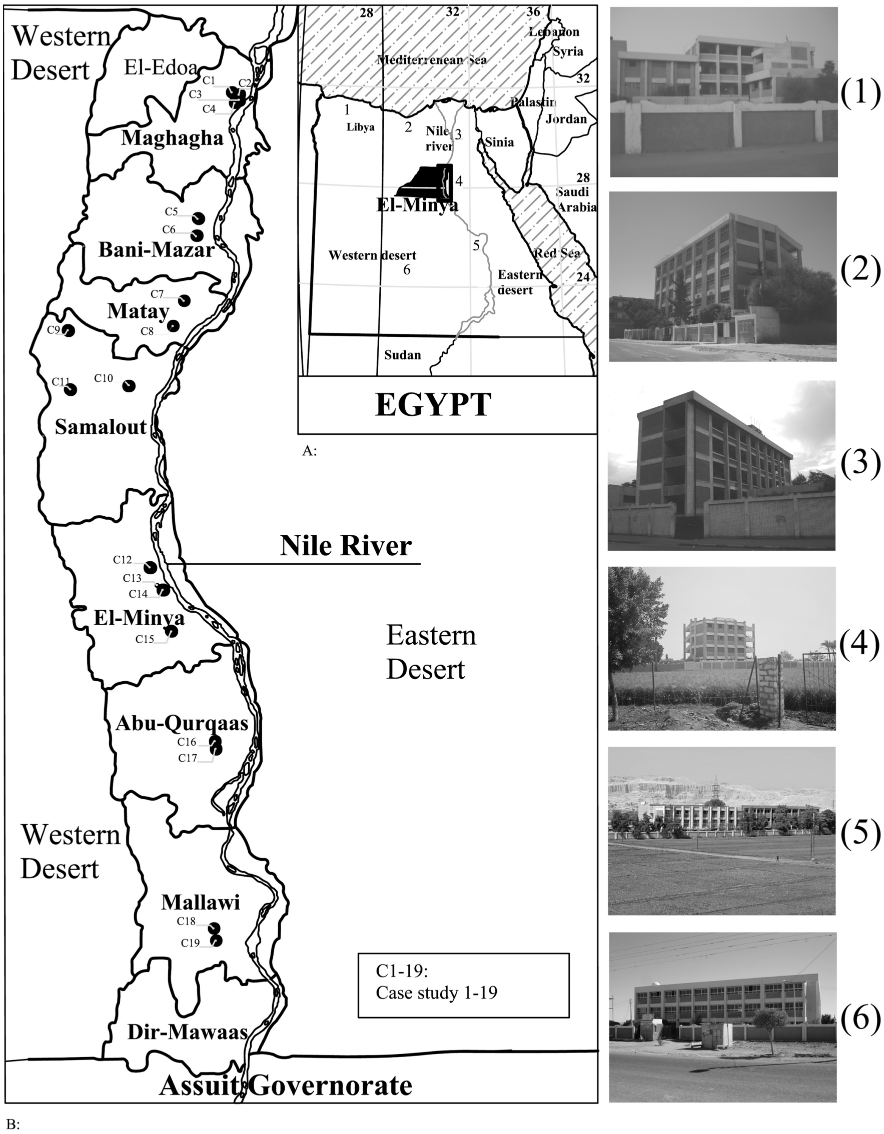


Figure 1: A: Examples of prototypical schools in different climatic zones / **B**: Location of the case studies in al-Minya Governorate

In the third stage, the thermal comfort inside five classrooms of three schools was investigated in details. Two schools were chosen from the 18 cases previously studied and an additional school was employed. The three schools were; Omar ebn al-Khatab primary school (leaner single Row Form), al-Lamaty primary school (leaner double Row Form) and al-Shaheed primary school (L-shape) (Figure 2 - Figure 4) These schools represent the three prototypes commonly built in al-Minya.

Figure 2: Omar ebn al-Khatab primary school

Figure 3: Al-Lamaty primary school

Figure 4: Al-Shaheed primary school

Multi-approached techniques were employed to collect data from 168 occupants (87% were pupils and 43% were female) inside the 5 classrooms during May 2007. Semi-structured interviews and questionnaires were employed. The questionnaire was used to collect data from occupants inside several classrooms at the same time. This allowed the comparison of data collected from different spaces within the same school but have for example different solar and wind orientations. However, since not all young children are capable of using conventional thermal comfort rating-scales (Humphreys 1977), interviews were used with children under 9 years old. Interviews included 24 closed ended questions and 7 open ended questions. Questionnaires included 24 closed ended questions. All the questions were related to the sensation of thermal comfort inside the classrooms. ASHRAE seven point scale (ISO 1998) was used to allow the interviewee to rate their perception of the thermal environment. Any difficult expression such as 'thermal comfort, slightly warm…etc' were explained to the subjects prior to the interviews or the questionnaires.

5.Results and discussion

Analysis of data collected from the first and second stages suggested that the majority of occupants were in discomfort for most of the academic year. 78% of the occupants were thermally uncomfortable, 58% were visually uncomfortable and 21% reported that the acoustics of the classrooms were poor (Figure 5).

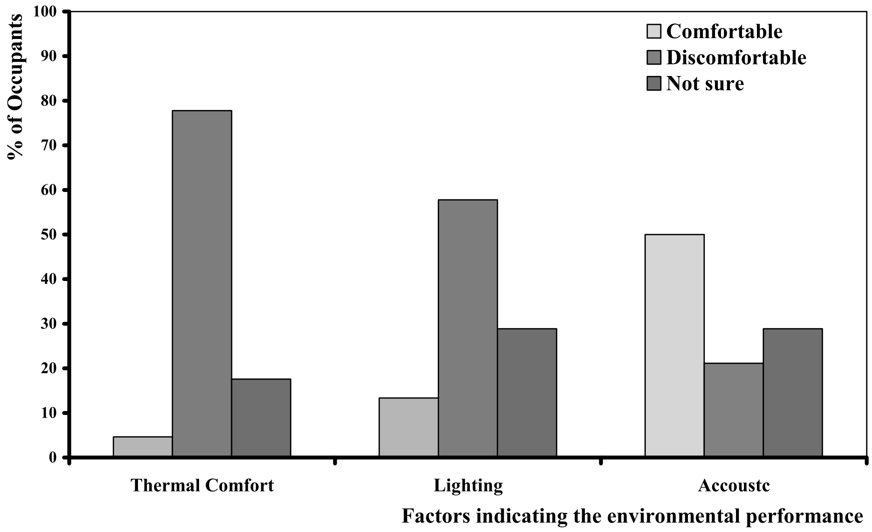


Figure 5: Percentages of occupants reporting discomfortable, comfortable or not sure

Analysis of data collected from stage three indicated that 86% of the occupants were thermally uncomfortable with only 14% reporting to be neutral. 34% of the uncomfortable subjects were hot, 18% were warm, 33% were slightly warm (Figure 6).

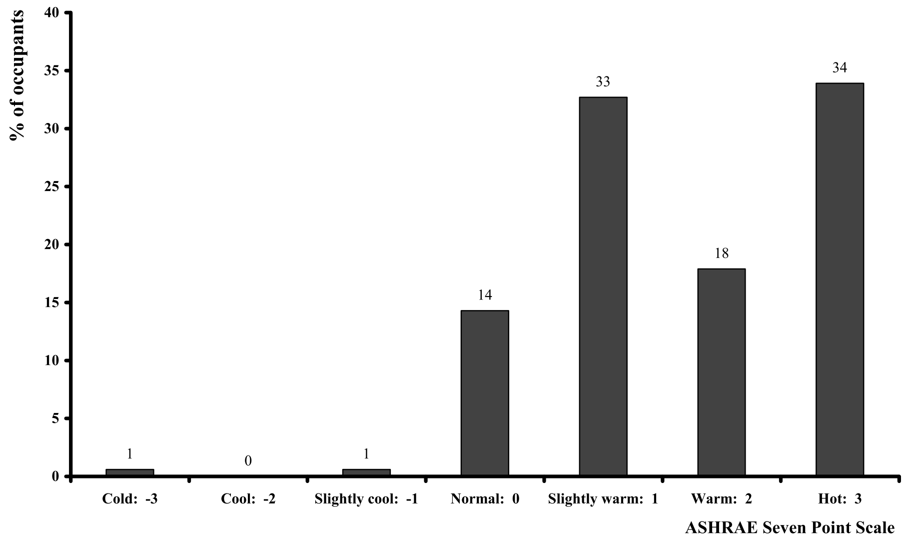


Figure 6: Percentage of occupants' response at each point on ASHRAE Seven Point Scale

Predicted Percentage Dissatisfied (PPD) was calculated using the data collected and was found to be 53%. This suggests that the majority of the occupants inside the case studies are thermally uncomfortable during the overheated period of the academic year. Observations and analysis of the case studies suggest that this could be due to several reasons:

- High occupancy density reaching 0.8 m^2/person in comparison to the average density in British classrooms that ranges from 1.8 to 2.4 m^2/person;
- The building envelope has a very low insulation capacity that ranges between 2.8 and 5.1 W/m^2.K with all external walls and roofs not thermally insulated;
- The high solar heat gain coefficient (SHGC) caused by the relative high window to wall ratio reaching 32% plus high incident solar radiation on windows (ex: incident solar radiation typically ranges between 327 and 900 w/m^2 on the 24th April at 2.00 pm);
- Inadequate solar orientation causing high solar gain through windows. This plus the high outdoor air temperature pushes the conditions inside the classroom outside the thermal comfort zone;
- High shading coefficient (SC) values due to the use of large un-shaded areas (8 m^2) of glazing. This caused almost 25% of the pupils occupying the classroom to be hit by direct solar radiation for prolonged periods of time during the overheated month. This beside the high indoor air temperatures reaching 36^{o}c can lead to thermal discomfort and can cause sunstroke in severe cases;
- Windows are single glazed and poorly constructed with very high levels of air permeability. This caused high levels of heat gain through ventilation during overheated periods and cold draughts during under heated periods;
- The design of windows does not allow natural ventilation;
- In some cases children and teachers had to paint the windows in dark colour or stick newspapers to avoid discomfort and disability glare caused by the direct solar radiation. (Figure 7). This consequently led to a severe drop in the levels of natural light and the use of artificial lighting during daylight hours consuming unnecessary energy. In most cases the informants confirmed that they can not open the windows any way to induce natural ventilation because of the high levels of air and sound pollution outside the schools. This lead to very low internal air speeds reaching less than 0.1 m/s with no simple mechanical ventilation provided. This also led to low levels of air change and consequently caused the classrooms to be stuffy and smelly;

Figure 7: Windows covered and painted by the occupants after Gado and Mohamed (Gado et al. 2005)

- In very few cases, when the occupancy density is low, children move places to avoid direct solar radiation disturbing by such the educational process. This does not solve the problem any way since overcrowding at shaded areas contributes to the children's thermal discomfort (Figure 8).

Figure 8: Directed solar radiation falling on the children, after Gado et. al. (Gado et al. 2005)

Sunny areas Shaded areas

6. Conclusions and further work

This research was concerned with the subjective assessment of thermal comfort inside governmental primary schools in Egypt as a representative context of hot dry climate. Semi-structured interviews and questionnaires were employed and 276 subjects were used. The results suggested that the majority of the occupants are thermally uncomfortable in most of the cases during most of the time.

Work is conducted to objectively assess the thermal performance of the classrooms and to further investigate the causes of the problem. Results of this work are presented in the second part of the paper.

7. References

Abdalla, S. (1994) "The philosophy of the new technological aspects on the development of the design of basic education schools and its influence on the human dimensions of the student", Unpublished MSc, Architecture Engineering Department, Cairo University, Giza.

Becker, R., I. Goldberger and M. Paciuk (2007) Improving energy performance of school buildings while ensuring indoor air quality ventilation, 'Building and Environment', volume 42, issue 9, 3261-3276.

BRE, B. R. E. (2003) Monitored carbon dioxide levels and ventilation rates in naturally ventilated primary schools, 'Monitoring of ventilation and indoor air quality (IAQ)', volume BRE.

Clements-Croome, D. J., H. B. Awbi and M. Williams (2005) Ventilation rates in schools. In: (Ed) The 10th International Conference on Indoor Air Quality and Climate, Beijing, 3223-3227.

Clements-Croome, D. J., H. B. Awbi, Z. Bako-Biro, N. Kochhar and M. Williams (2008) Ventilation rates in schools, 'Building and Environment', volume 43, issue 3, 362-367.

Cook, G. K. (1990) Artificial lighting in classrooms--results of a lighting survey, 'Building and Environment', volume 25, issue 4, 329-331.

Corgnati, S. P., M. Filippi and S. Viazzo (2007) Perception of the thermal environment in high school and university classrooms: Subjective preferences and thermal comfort, 'Building and Environment', volume 42, issue 2, 951-959.

Edwards, L. and P. Torcellini (2002) A literature review of the effects of natural light on building occupants, volume National Renewable Energy Laboratory.

El-Hefnawy, M. (2002) "Safety and security in educational buildings, using computer to evaluate and verify the level of safety for basic educational schools", Unpublished PhD, Architectural Engineering Department, Cairo University, Giza.

El-Mola, N. (1999) "Utilizing architectural spaces for the development of children culture awareness a case study in low income communities", Unpublished MSc, Architecture Engineering Department, Ain Shams University, Cairo.

El-Nashar, E. (1998) "The impact of spatial form on children", Unpublished PhD, Architecture Engineering Department, Helwan University, Cairo.

Farag, F. (2002) Shaken not stirred, 'Al-Ahram', volume issue 601,

Gado, T., M. Mohamed and S. Unwin (2005) The environmental performance of classrooms in Egypt: a case study from El-Minya governorate. In: P. C. O. Egbu and M. K. L. Tong (Ed) The Second Scottish Conference for Postgraduate Researchers of the Built & Natural Environment (PRoBE 2005), 16-17 November 2005, Glasgow Glasgow Caledonian University, 643-651.

GAEB (2004) "Authority prototypes after the earthquake". Cairo: General Authority of Educational Buildings - Architectural design department - Researches and studies administration.

Galasiu, A. D. and J. A. Veitch (2006) Occupant preferences and satisfaction with the luminous environment and control systems in daylit offices: a literature review, 'Energy and Buildings', volume 38, issue 7, 728-742.

Humphreys, M. A. (1977) A study of the thermal comfort of primary school children in summer, 'Building and Environment', volume 12, issue 4, 231-239.

ISO (1998) Ergonomics of the thermal environment—instruments for measuring physical quantities. ISO 7726, volume

Kruger, E. L. and P. H. T. P. H. T. Zannin (2004) Acoustic, thermal and luminous comfort in classrooms, 'Building and Environment', volume 39, issue 9, 1055-1063.

Kwok, A. G. and C. Chun (2003) Thermal comfort in Japanese schools, 'Solar Energy', volume 74, issue 3, 245-252.

Lin, Z., T. T. Chow, K. F. Fong, Q. Wang and Y. Li (2005) Comparison of performances of displacement and mixing ventilations. Part I: thermal comfort, 'International Journal of Refrigeration', volume 28, issue 2, 276-287.

Noufal, M. (1998) "Development of environmental planning techniques for school buildings in overcrowded districts", Unpublished MSc, Architectural Engineering Department, Ain Shams University, Cairo.

Shalabi, E. (1996) "The integration between the educational program and the architectural program", Unpublished MSc, Architecture Engineering Department, Ain Shams University, Cairo.

Stansfeld, S. and M. Haines (2002) Noise exposure from various sources - cognitive effects on children in the report of the technical meeting on exposure-response relationships of noise on health, volume European Centre for Environment and Health, World Health Organization Regional Office for Europe, Bonn Office.

Stewart, D. M. (1981) Attitudes of school children to daylight and fenestration, 'Building and Environment', volume 16, issue 4, 267-277.

Toulan, N. (1982) "The design methods of primary schools in Egypt", Unpublished MSc, Architecture Engineering Department, Cairo University, Giza.

Wong, N. H. and W. L. S. Jan (2003) Total building performance evaluation of academic institution in Singapore, 'Building and Environment', volume 38, issue 1, 161-176.

Wyon, D., I. Andersen and G. Lundqvist (1979) The effects of moderate heat stress on mental performance, 'Scand J Work Env Hea', volume issue 5, 352-361.

8. Acknowledgment

The authors would like to thank the Egyptian Ministry of Higher Education for the full PhD scholarship granted to the second author Mady Mohamed. The later is an assistant lecture on a sabbatical leave funded by Zagazig University. Mr. Mohamed would like to thank the Zagazig University and the Egyptian Government for their financial support and the Egyptian Education and Culture Bureau in London for their effort in managing his scholarship. He would also like to thank Dundee School of Architecture for the continued support. Thanks are also due to Mr. Don Alexander of the Welsh School of Architecture for providing the authors with HTB2.

Assessment of thermal comfort inside primary governmental classrooms in hot-dry climates Part II – a case study from Egypt

Tamer Gado[1], Mady Mohamed[2]

1 – University of Dundee, UK

2 – Zagazig University, Egypt

Previous work (Gado and Mohamed, 2009) investigated the subjective response of occupants inside nineteen primary schools in Egypt with regard to their state of thermal comfort. The results of this work, suggested that the majority of occupants were thermally discomfort for most of the time during the academic year. This paper presents an objective assessment of the thermal comfort inside three case studies out of the nineteen schools previously studied. These three case studies represent the most common school prototypes built by the General Authority of Educational Buildings (GAEB) in Egypt. The three prototypes are: Single Row Linear Form (SRLF), Double Row Linear Form (DRLF), and L Form (LF). Human and environmental factors affecting thermal comfort were monitored during the hottest month of the academic year. Results suggested that thermal performance of classrooms in terms of thermal comfort was poor, justifying by such the results of the subjective assessment previously published.

Keywords: assessment, assessment tools, environmental assessment, performance, sustainable buildings

1. Introduction

In the first part of this paper, thermal comfort inside nineteen case studies was subjectively assessed. Analysis of results suggested that the occupants were thermally discomfort most of the time during the academic year. This part of the paper presents the findings of a study where thermal comfort inside three case studies out of the nineteen schools was assessed objectively.

2. Research background

It is relatively difficult to access thermal comfort inside buildings due to the complexity of the contributing factors deciding whether the conditions in question will make people feel discomfort or not. It is generally agreed that factors affecting thermal comfort inside buildings can be grouped into two groups; human factors and environmental factors. The later include air temperatures, air velocity, mean radiant temperature and relative humidity while the human factors include insulating value of clothing (Clo) and the metabolic rate (Met) that depends on the activity level. Szokolay added a third category and called it the contributing factors that include the person's age, gender, food, drink, body shape, subcutaneous fat, colour of internal surfaces and lighting system used (Szokolay 2004). Fanger and Humphreys (Humphreys 1977) in addition to several studies cited in ((CIBSE 1999), pages 1-10) revealed that, at a given activity and clothing level those contributing factors do not significantly affect thermal comfort.

From all the environmental factors, air temperature is the most commonly used indicator of thermal comfort (Rosenlund 2000) and is considered to be the most important factor determining heat stress. Mean radiant temperature which is determined by the temperature of the surrounding surfaces is also a significant factor contributing to thermal comfort. Relative humidity is another important factor affecting thermal comfort. High levels of humidity inside buildings prevent the evaporation of sweat from skin; the main method human body losses heat (Givoni 1976). In hot climates this could have a significant effect on the thermal comfort. On the contrary, low humidity levels can cause symptoms such as dryness of throat and skin, and can cause irritation of the mucous membranes. In normal circumstances, relative humidity should range from 40 to 70% (CIBSE 1999). Another factor affecting thermal comfort is air movement which is not to be confused with air change and is not always caused by ventilation (McMullan 2002). It affects the evaporative capacity of the air and consequently the cooling efficiency of sweating (Givoni 1976). Air movement helps the heat loss from human body by convection, but it can in some cases cause the sensation of draught (McMullan 2002). A related factor to air movement is the ventilation rate. Results from previous research (Ajiboye et al. 2006; Clements-Croome et al. 2005; Coley and Beisteiner 2002; Griffiths and Eftekhari 2008) suggested that children studying in ill ventilated classrooms are likely to be less attentive. The concentration of carbon dioxide (as an indication of ventilation rate) in all teaching and learning spaces at seated head height should not exceed 1500 ppm (Department for Education and Skills 2005). The minimum required ventilation rate in any teaching area is 3 l/s per person. It is recommended that the ventilation approach used in school buildings should be capable of providing an enhanced rate of at least 8 l/s per person to be able to handle sudden increase in ventilation needs (Kukadia et al. 2005).

3. Monitoring methodology

Five classrooms inside three case studies from the previously investigated nineteen schools in part 1, were chosen. The layout and typical plans of the schools are presented in Figure 1- Figure 3. The environmental factors affecting thermal comfort (air temperature, relative humidity, mean radiant temperature, and ventilation rate) were monitored during the same time of the subjective assessment. This took place during the hottest months of the academic year; May. This allowed the comparison between the subjective response of occupants and the objective assessment of the environments.

Figure 1: Case study 1 layout

Notes: a) classroom under investigation is hatched

b) Numbers on surrounding buildings are their height in meters

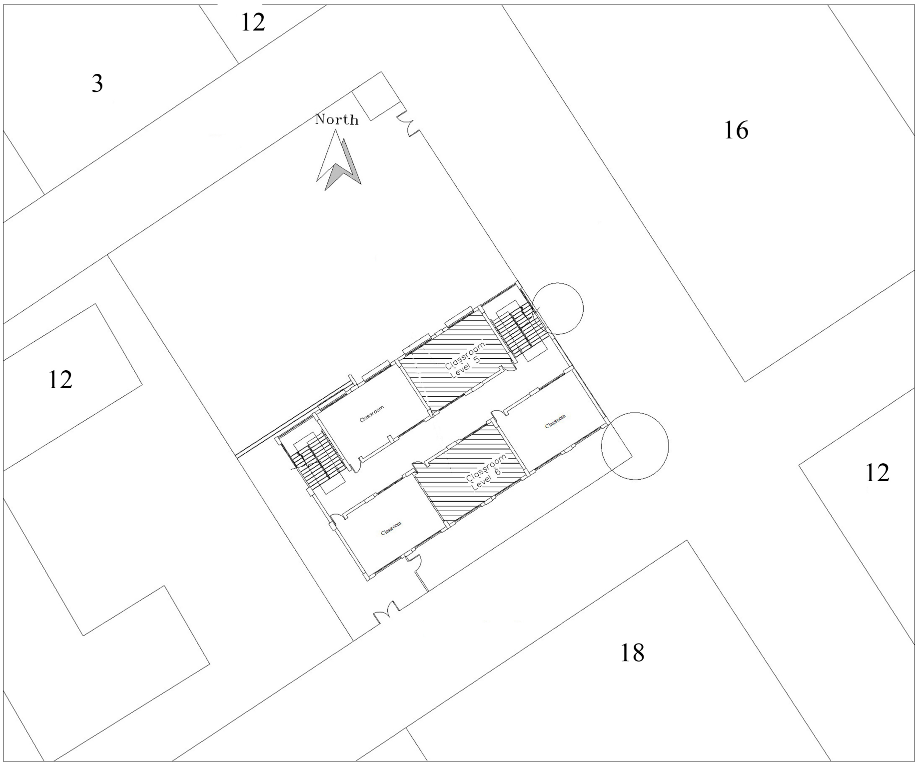


Figure 2: Case study 2 layout

Notes: a) classrooms under investigation are hatched

b) Numbers on surrounding buildings are their height in meters

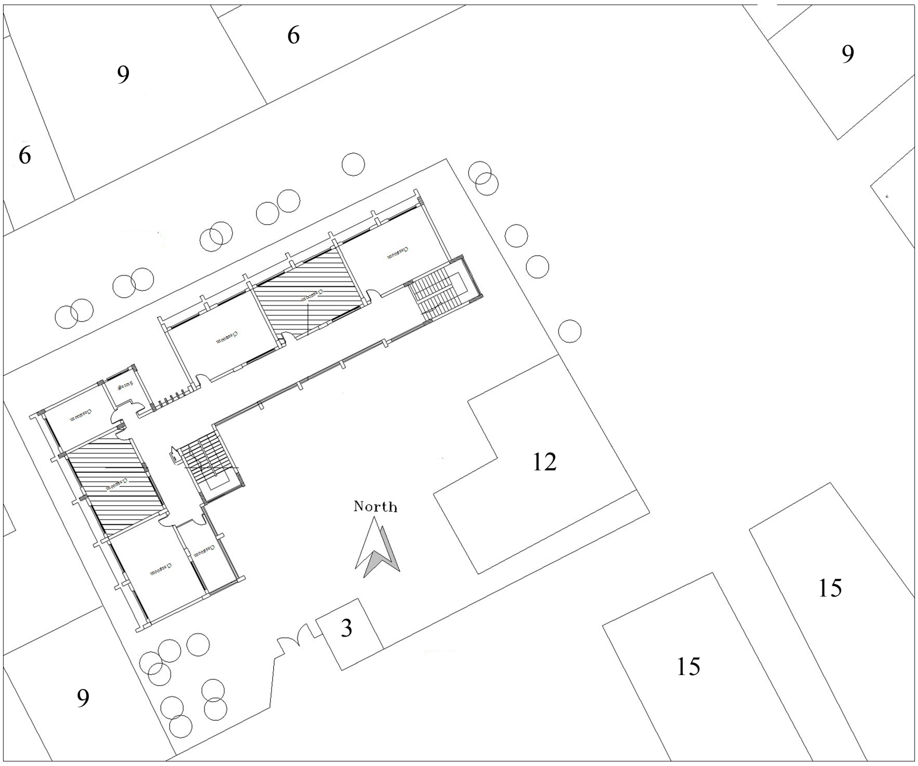


Figure 3: Case study 3 layout

Notes: a) classroom under investigation is hatched

b) Numbers on surrounding buildings are their height in meters

Due to the young age of occupants, it was important to choose a reliable data logger that could be easily concealed away from the children and can be quickly installed while accurately logging and storing data for the duration of the investigation. For this Hobo U12 was chosen to log air temperature and relative humidity. Two external sensors (TMC6-HD) were connected to the logger to allow taking measurements at three levels as shown in Figure 4 and Figure 5) a) ankle level (200 mm above floor level) b) head height (1100 mm above the floor, the standard height according to ISO 7726:1998 (ISO 1998) c) below the ceiling height by 200 mm (Figures 4-5).

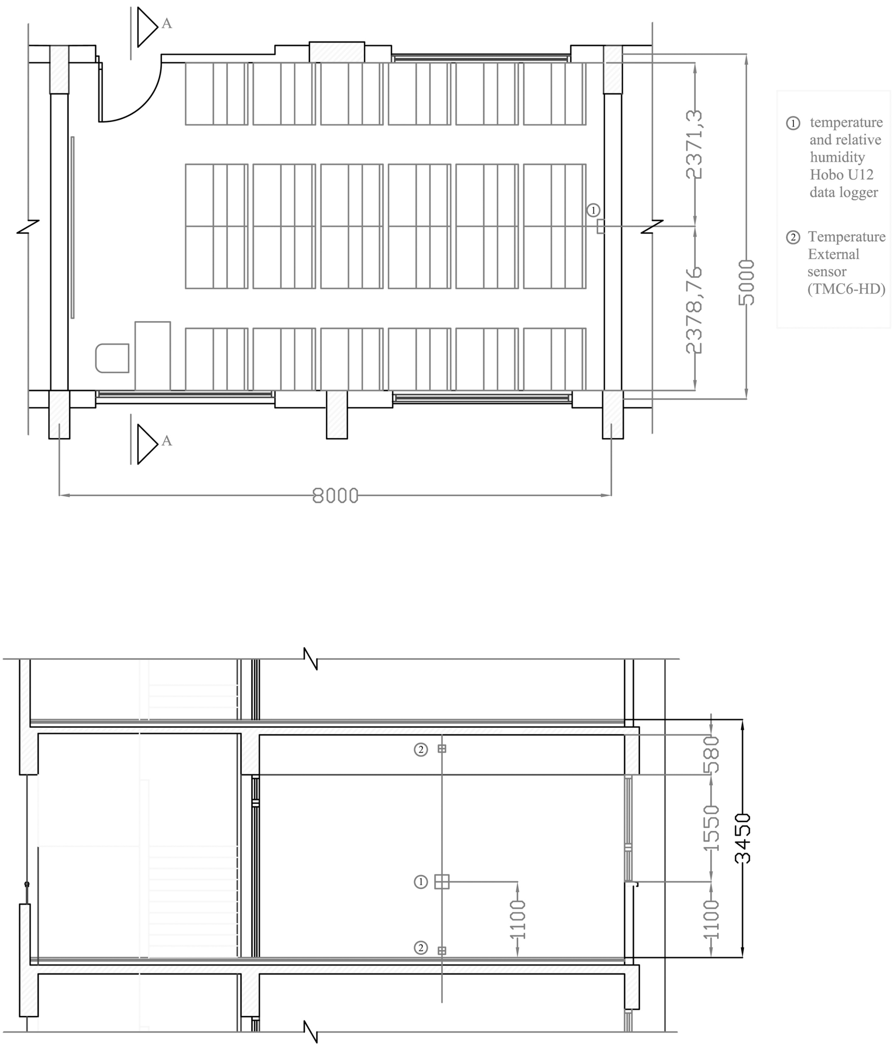


Figure 4: Location of the Hobo U 12 data logger and sensors inside the classroom

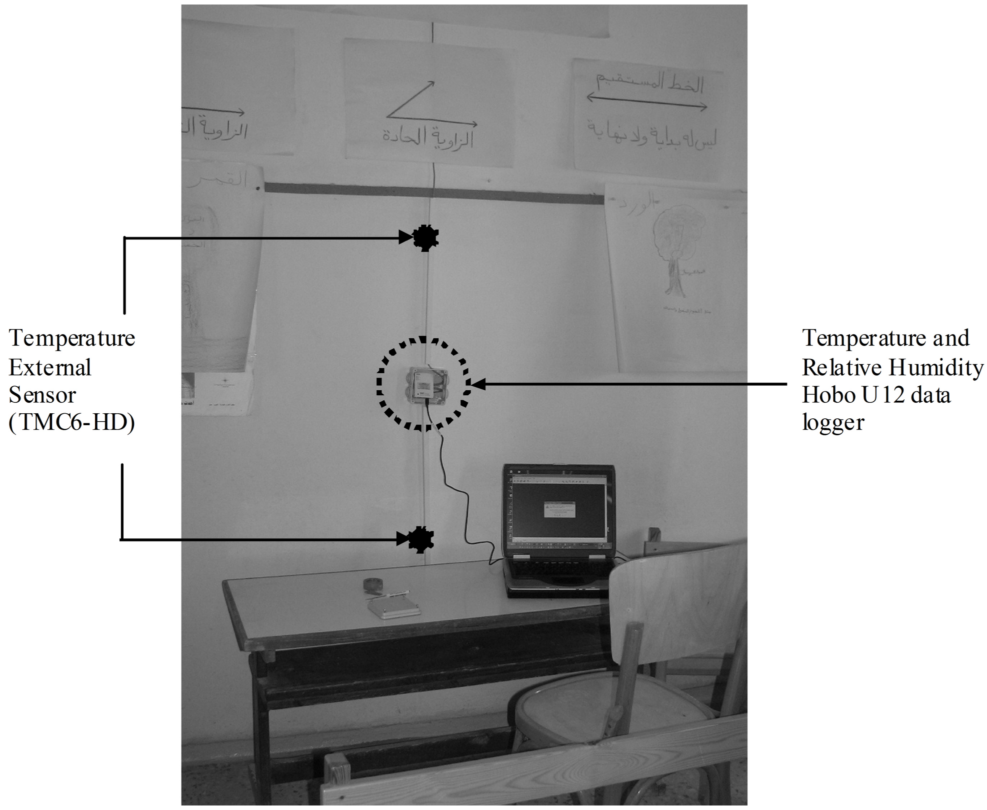


Figure 5: Hobo U12 and sensors on the back wall of the classroom

Measuring the temperature at those levels allowed studying the temperature stratification inside the classroom; a factor affecting thermal comfort. The effect of temperature stratification is important since a large difference between head and ankles temperature can cause discomfort (ISO 1998). Ideally, the feet should be a few degrees warmer than the head (Environmental Engineering Science 2007) and this should not exceed 3oC (CIBSE 1999). Studying this factor will also generate data to allow further work to investigate the application of passive ventilation systems.

Internal air speeds were measured at several points over a period of a day using a hand held anemometer. Ventilation rate was gauged by logging the CO2 concentration levels every two seconds over a single day using a TEL-7001 Telaire CO2 Monitor H22-001 sensor and a Hobo FlexSamrt data logger. CO2 levels was used as an indication of the indoor air quality and ventilation rates inside the classrooms (ASHARE and American Society of Heating 1999). In this case, it was not possible to log the CO2 inside the classrooms over the whole month as it was not possible to leave the monitoring equipment unattended.

Mean radiant temperature were calculated using the surrounding surfaces temperatures at seated head level at the centre of the classroom using equation 1 (ASHRAE 2005) and the angle factor between the location and the measured surfaces was determined graphically using ASHRAE hand book method (ASHRAE 2005).

$$tr = t_1^{\ 4} Fp\_1 + t_2^{\ 4} Fp\_2 + \ldots\ldots + t_n^{\ 4} Fp\_n \quad \text{equation 1}$$

Where

Tr= mean radiant temperature

TN^4 = surface temperature of surface N

Fp_N = angle factor between a person and surface N

An infrared thermometer (MicroRay Pro++) was used to measure the temperatures of all the internal surfaces of the classroom. The equipment used is a high-end thermometer that features adjustable emissivity allowing the measurement of the temperature of any surface irrespective of its material.

Outdoor climatic conditions were logged over the same period using Hobo microstation (H21-002). Measurements included air temperature, relative humidity, and direct solar radiation. This data were then compiled and a meteorological data file for Al-Minya was created.

4. Results and discussion

Clothing level affects heat exchange between the body and the surrounding environment by forming a barrier to the convective and radiative heat exchange between the body and the environment (Givoni 1976). Different cloths will have different effects on the required comfort temperature. It was found during the field study that children's ability inside the classrooms to adapt their clothing level by adding or removing layers of clothing according to their thermal environment was very limited. The boys' typical uniform at the time of the survey was a long sleeve shirt or tee-shirt and a long trousers, socks and shoes. Girls' typical uniform was a dress with long trousers, socks and shoes. In some cases their clothes were similar to the boys' uniform. Normal underwear was assumed to avoid offence. In all cases it was found that the clothing was equivalent to a value of 0.7clo (ISO 1998).

Level of activity affects the metabolic rate which in turn affects the body temperature. Under the current Egyptian education system, children inside primary classrooms are seated in pairs on a 900mm wide wooden desk for long periods of time. This level of activity metabolic rate is equivalent to 70w/m2. The average total number of children per classroom under investigation was 48 i.e. 0.83 m2/pupil. This high density is expected to contribute to the level of thermal discomfort. The classroom furniture is arranged in three rows perpendicular to the blackboard as seen in Figure 4. Children in this setup are normally not allowed to change there location during the lessons. This means that almost 25% to 35% of the children are left in direct solar radiation (Figure 6) across the academic year depending on the time of the day and the solar orientation.

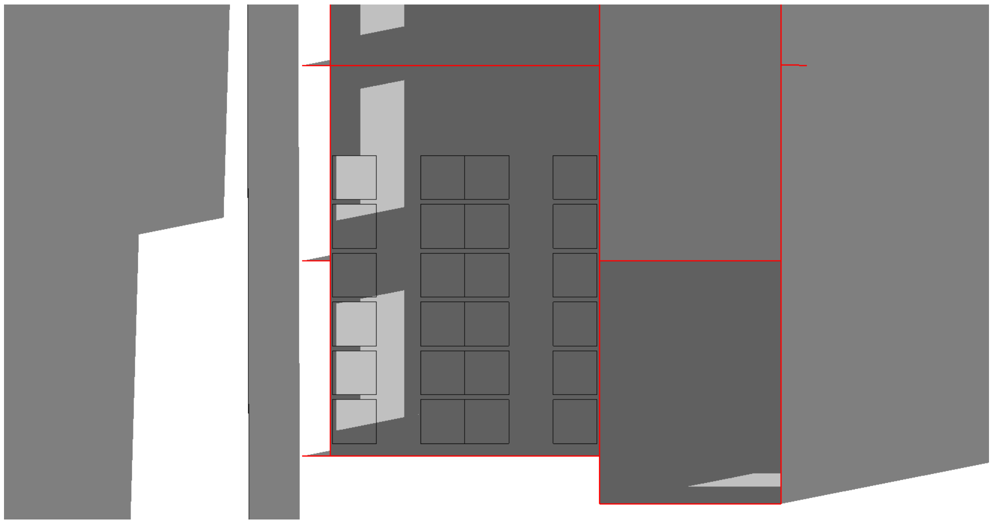


Figure 6: Solar penetration at 14:00 during mid May

All the classrooms under investigation were naturally ventilated. However, there were several reasons that prevented the effective use of windows. They were closed most of the time and in many cases were painted in black or covered with newspaper to prevent solar penetration. This consequently led to a severe drop in air speeds, which were less than 0.1 m/s across the five cases. Even when all the windows were opened, air speeds were not noticeable inside the classroom and slightly exceed 0.1 m/s only near the windows.

CO2 levels in two of the five classrooms exceeded the recommended levels of 1500ppm (Department for Education and Skills 2005) reaching 2142ppm and 1908ppm respectively. In is worth mentioning that there were no measures in place that could respond to sudden ventilation needs.

The average internal air temperature across the case studies was 29oC. It exceeded 30oC for 23% to 48% of the time, reaching just over 34oC in some cases. Over a single day the internal temperature varied by more than 2oC during 58% of the time across the case studies. According to Humphreys (Humphreys 1977) this level of variation in internal air temperature could result in incident of discomfort. Humphreys suggested this might be due to that fact that children are sent to the schools wearing relatively warm cloths in the cool morning than required for the range of temperature during the day. In the context of this work, this could only be true during winter when morning temperatures are relatively low ranging from 06oC to 119oC at 8am. Air temperature at head level was always higher than the temperature at the feet level by an average of 0.5oC reaching in some cases a difference of over than 2oC for 20% of the time increasing by such the state of thermal discomfort.

Levels of internal relative humidity ranged from 17.8% to 52.6 % during the operation hours. For 80% to 96.4% of the time, relative humidity was under 40% across the case studies and was less than 30% for 5% to 41% of the time. This low level of humidity may be acceptable for short periods as long as there are precautions to limit the generation of dust and airborne irritants (CIBSE 1999). In this case, there were no precautions taken to limit this from occurring and in turn this increased the discomfort of occupants as suggested by the subjective assessment.

The year during which this work was conducted was slightly hotter than the typical meteorological year. Typically the average outdoor air temperature in Al-Minya during the school operation hours (8am - 1pm) is 26oC, reaching a maximum of 40.5oC. However, in this case the average outdoor air temperature was 31.4oC reaching a maximum of 43oC. Typical average direct solar radiation is 630w/m2 when the typical value is 525w/m2.

5. Assessment of thermal comfort

In this study, two methods were employed to assess the thermal comfort inside the case studies: 1) comparing the internal temperatures with the comfort temperature 2) calculating the PMV and PPD values for the classrooms.

Using the adaptive thermal comfort model, the monthly comfort temperature and the total number of hours spent above this limit during the operation hours of the day was calculated. Figure 7 presents the internal air temperatures across the five case studies in relation to the comfort limit. Analysis of results suggested that the internal air temperature across the classrooms exceeded the comfort limit for 82.26% of the time and exceeded it by 2oC for 43.55% of the time (Figure 7).

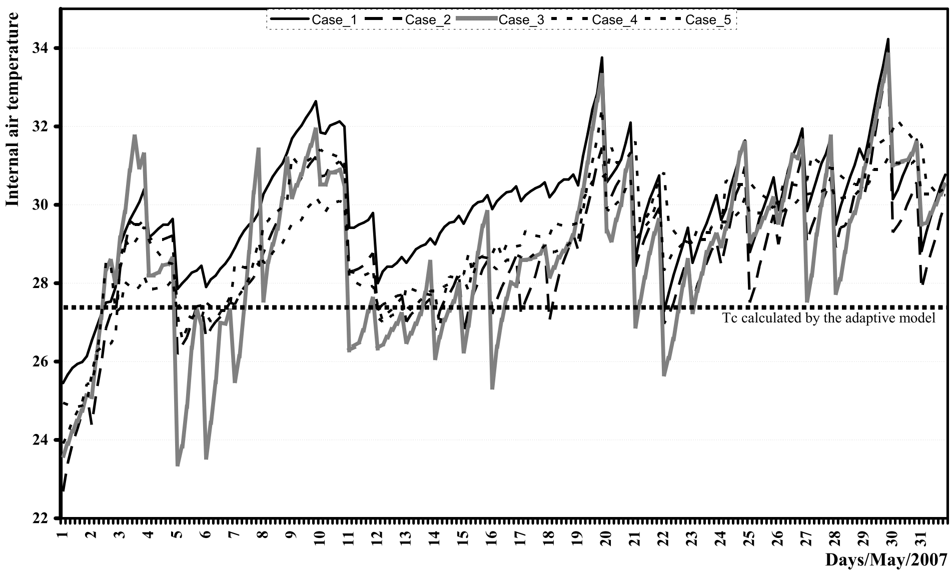


Figure 7: Internal air temperatures across the five case studies in relation to the thermal comfort temperature

The two indices widely used to predict the state of thermal comfort of occupants inside buildings are the Predicted Mean Vote (PMV) and the Predicted Percentage Discomfort people (PPD). Both the PMV and the PPD of each classroom were calculated during the operation hours (08.00 am to 01.00 pm). The average PMV and PPD across the classrooms was 1.7 and 51% respectively indicating by such a high level of thermal discomfort. The later confirms the PPD found in previous work (Gado and Mohamed In review) that was equal to 53%.

6. Conclusions

This paper was concerned with the objective assessment of thermal comfort inside three primary schools built in the desert climatic design region of Egypt. All factors affecting thermal comfort were monitored and analysed. The adaptive thermal algorithm was used to calculate the comfort temperature and both the

PMV and PPD indices were calculated. The conclusions from the analysis of results can by summarised as follows:

1. The internal air temperatures of all the case studies exceeded the comfort temperature for most of the time;
2. Half the occupants were thermally discomfort. This was indicated by the average PPD that reached 51%;
3. Temperature difference between the head and the ankle level exceeded 2 degrees for 20% of the time;
4. Average PMV across the case studies was 1.7 suggesting that the majority of the occupants would feel warm.

7. Further work

Further work will investigate ways of enhancing the environmental performance of the prototypes used by the Government in Egypt. A computer based study is under way to quantify the effectiveness of a number of passive measures and strategies used to enhance the performance of the typical designs investigated in the paper. Further work will also investigate the effect of the climatic variation across the Egyptian climatic design regions on the thermal performance of the Governmental prototypes.

8. References

Ajiboye, P., M. White, H. Graves and D. Ross (2006) Ventilation and indoor air quality in schools - Guidance Report 202825, 'Building Research Technical Report', volume 2006,

ASHARE and R. American Society of Heating, and Air-Conditioning Engineers (1999) ASHRAE Standard 62-1989: Ventilation for Acceptable Indoor Air Quality, volume

ASHRAE (2005) "ASHRAE 2005 Fundamentals Handbook".

CIBSE (1999) "Environmental design, CIBSE Guide A". London: Yale Press Ltd.

Clements-Croome, D. J., H. B. Awbi and M. Williams (2005) Ventilation rates in schools. In: (Ed) The 10th International Conference on Indoor Air Quality and Climate, Beijing, 3223-3227.

Coley, D. A. and A. Beisteiner (2002) Carbon dioxide level and ventilation rates in schools, 'International journal of ventilation ', volume issue 45-52.

Department for Education and Skills, D. (2005) Building Bulletin 101, Ventilation of School Buildings, 'Building Bulletin', volume 2006, DfES.

Egyptian organisation for energy conservation and planning (1998) "Architecture and energy manual". Cairo: Egyptian organisation for energy conservation and planning.

Givoni, B. (1976) "Man, Climate and Architecture". London: Applied science publishers LTD.

Griffiths, M. and M. Eftekhari (2008) Control of CO2 in a naturally ventilated classroom, 'Energy and Buildings', volume 40, issue 4, 556-560.

Humphreys, M. A. (1977) A study of the thermal comfort of primary school children in summer, 'Building and Environment', volume 12, issue 4, 231-239.

ISO (1998) Ergonomics of the thermal environment—instruments for measuring physical quantities. ISO 7726, volume

Kukadia, V., P. Ajiboye and M. White (2005) "Ventilation and indoor air quality in schools". Watford: BRE Bookshop.

McMullan, R. (2002) "Environmental science in building". Basingstoke: Palgrave Macmillan.

Rosenlund, H. (2000) Climatic design of buildings using passive techniques, 'Buiding issues', volume 10, issue

Szokolay, S. V. (2004) "Introduction to architectural science: the basis of sustainable design". Oxford: Architectural press.

9. Acknowledgment

The authors would like to thank the Egyptian Ministry of Higher Education for the full PhD scholarship granted to the second author Mady Mohamed. The later is an assistant lecture on a sabbatical leave funded by Zagazig University. Mr. Mohamed would like to thank the Zagazig University and the Egyptian Government for their financial support and the Egyptian Education and Culture Bureau in London for their effort in managing his scholarship. He would also like to thank Dundee School of Architecture for the continued support. Thanks are also due to Mr. Don Alexander of the Welsh School of Architecture for providing the authors with HTB2.

Keyword Index

Author Index

Sponsored by:

CIRIA
sharing knowledge
building best practice

Sustainability Research School
Loughborough University

WLC whole life consultants ltd.

SCC
Scottish Construction Centre

University of Dundee

Glasgow Caledonian University

Loughborough University

University of St Andrews

EPSRC
Engineering and Physical Sciences Research Council